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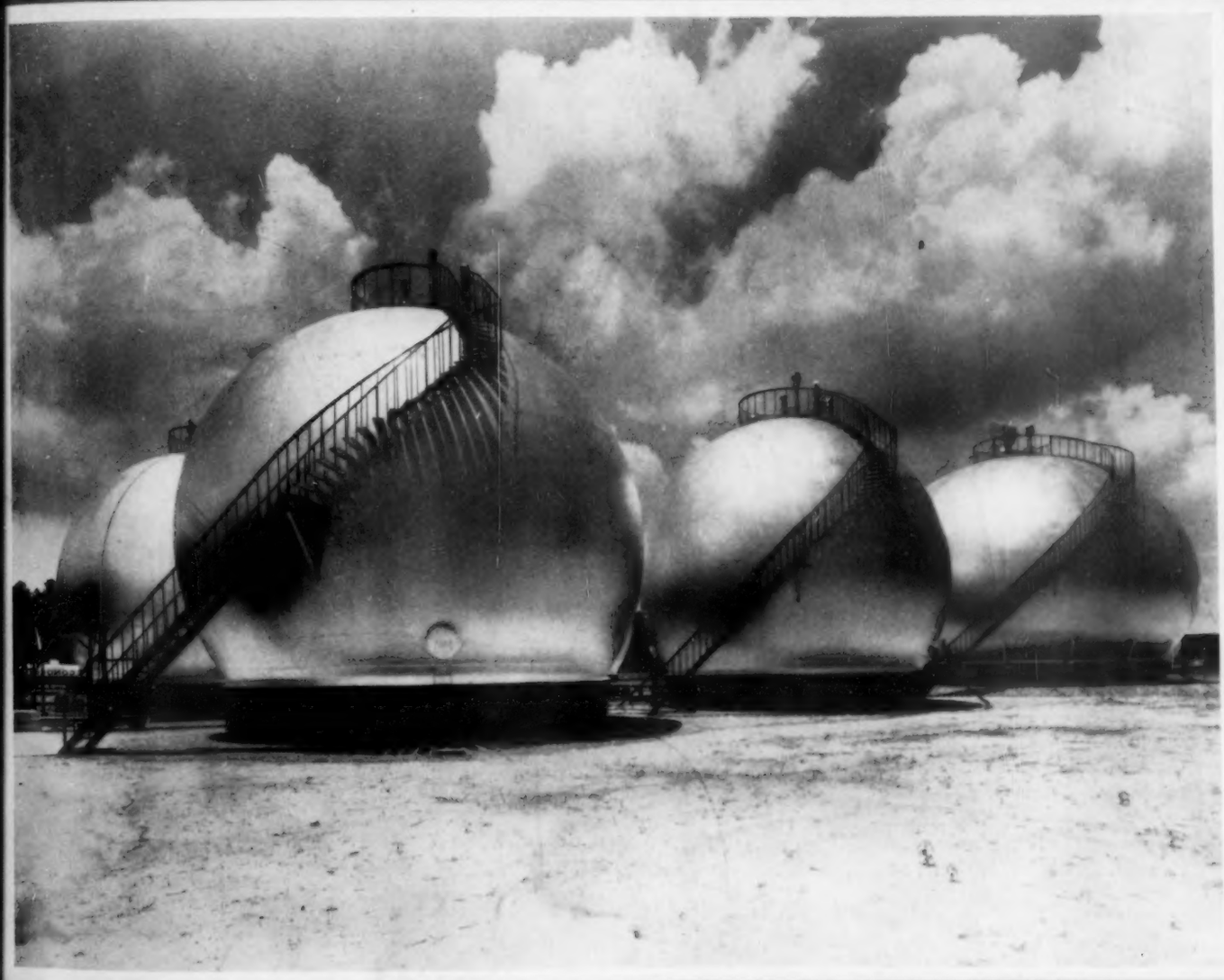

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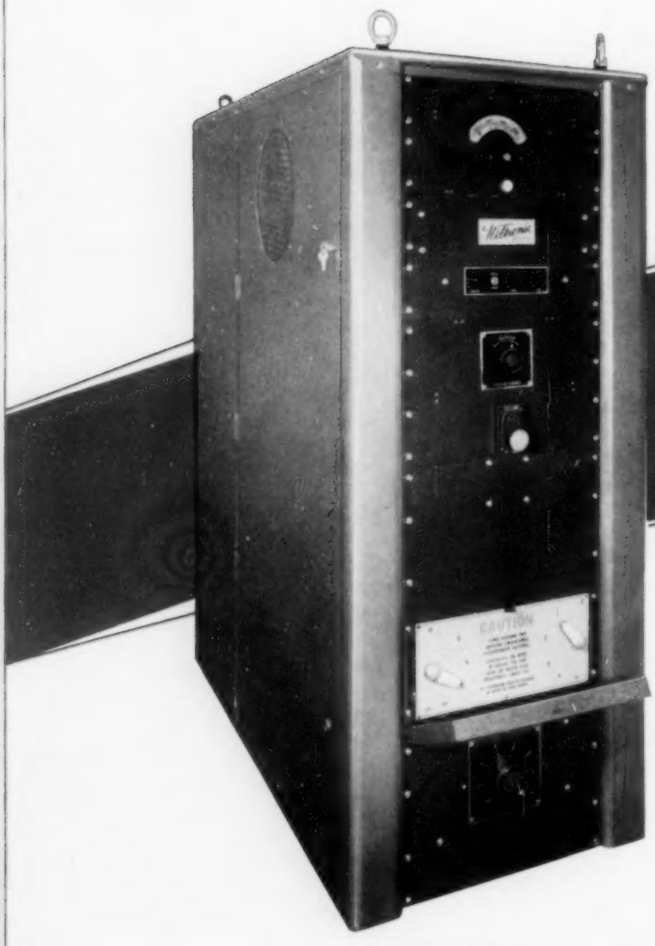

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Residual Stresses in Welded Ships*

By Harry W. Pierce†

Introduction

WHILE it is true that fears of residual and lock-up stresses in welded ships have been largely dissipated by the service performance of scores of these vessels, the subject still retains interest to designers and especially those charged with the rules and specifications bearing on the safety of such ships. In highly stressed ships, particularly, this subject is yet quite live and continues to be brought up, too frequently, in considering proposed methods which violate some of the old conceptions. It therefore warrants some analysis toward the end that new methods may receive consideration without unwarranted emphasis on the existence of residual stress.

Individual metal parts are assembled for service in a variety of ways; by solder, rivets, bolts or screws, brazing or welding. The last-named method is, therefore, merely one way of accomplishing the fabrication of any item, be it a machine tool, a building or a ship. As a method, it has its own peculiar advantages and disadvantages. No effort will be made here to discuss the reasons why welding has made such an advance in shipbuilding. It is more to the point now to see what the effect has been and to consider in some detail some of the peculiar problems presented by the wide adoption of welding.

However, for those not directly in touch with the production end of shipbuilding, a brief survey of the effect of welding on a shipyard plant may be both interesting and valuable as an indicator of the importance of some of the welding problems. In yards originally organized and operated long before the advent of welding, we now find that roughly 10% of the total personnel and an even higher percentage of production workers are welders, tackers and burners. This force ordinarily comprises either a separate or a subdepartment in the yard, and in practically all cases, is now the largest department in a shipyard.

The equipment angle has likewise undergone tremendous change. Many new yards are operating entirely without riveting tools or equipment. At New York Ship welding equipment has grown from some 20 individual motor-generator sets in 1928 to a point where the total output of welding equipment is well over 100,000 amps. and, allowing for the so-called working or duty factor, can supply over 1000 welding stations. The effect on certain crafts which originally formed a large percentage of the shipyard payroll, notably the riveters, and on electrical power can well be imagined.

Shipbuilding has embraced every type of welding. Here again, as an example, resistance welding is used for practically all shop-fabricated sheet metal work in aluminum, steel and Monel; oxyacetylene welding for aluminum and for pipe; carbon arc welding for many non-ferrous items, principally brass and bronze heat exchangers; Thermit welding in castings, forgings and other heavy intersections. However, the bulk of shipyard welding consists of the metallic arc for the general fabrication of hulls, machinery, piping, hull fittings and pressure vessels. Welding, directly or indirectly, has affected every department, every craft and even the layout of the modern shipbuilding yard.

Somewhat like a river which can either be made to serve man or to drown him, welding can improve our ships and speed up their construction or it can, in many cases, be a burden. Which of these it is depends chiefly upon the manner in which it is applied and accomplished and how much plain common sense as well as good engineering are employed. The degree of success in putting this new tool or method to work is dependent upon the way in which everyone concerned recognizes its peculiarities and is willing to face and solve the problems involved in welded ships.

When a ship is riveted together, the parts are gotten out to exact size, bolted in place and after riveting, for all practical purposes, are in the same place and in the same state as assembled. It was therefore possible to lay down the ship's lines in the mold loft, get out templates of all parts, and to fabricate these parts with practically all holes shop drilled or punched. The erector then had plenty of holes to guide him and after the shipfitter had added his touches and the holes were reamed full size, the riveter completed the connection by driving home his rivets. In welding, on the other hand, we deal in high temperatures and molten metal which freezes and shrinks. The heat of the arc is intense enough to raise surrounding parts to appreciable temperatures so that we have additional shrinkage and distortion. We therefore have, in most welded structures, a change in dimension and a change in shape. To arrive at a given result, we must actually start with something different and by allowing for or controlling in some measure, these changes arrive at the designer's idea. This is fundamental and the basic reason for change in shipyard methods for revision of shop and ship practices. Ninety per cent of the difficulty we get into in welded ships is the failure or the refusal of those concerned to recognize this inherent matter of shrinkage.

* Presented in part before the January 13th Meeting, New York Section and March 10th Meeting, Philadelphia Chapter of the Society of Naval Architects and Marine Engineers.
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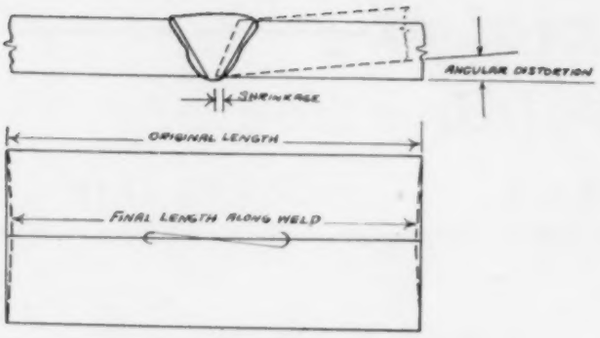


Fig. 1—Butt Joint

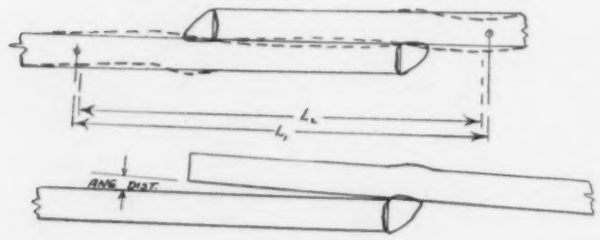


Fig. 2—Lap Joint

A fitter will cut a plate to exact size and then damn welding because after welding, it is not the right size, the right length or the right shape. Practically all ship construction is accomplished by the use of three types of joints—the butt, the lap and the tee. Figures 1, 2, 3 and 4 illustrate the shrinkage behavior of these three joints and indicate the problem involved in compensating for loss of length and change of shape. The solution of these problems is chiefly a matter of shop and ship practice; however, the designer can help in several ways:

1. By reducing the amount of welding in any joint to the minimum necessary to do the work.
2. By the use of joints where practicable, which balance forces tending to cause distortion.
3. By the arrangement of joints to permit allowances for shrinkage, subassembly and sequences of welding which reduce or sometimes eliminate trouble.

Close cooperation between the Yard and Drawing Room is a necessity until methods and results are better known and have been standardized. Frankly, developments of one sort or another have been coming so fast that "best" practice changes almost from day to day.

While change of dimension (loss of length) and change of shape (distortion) are serious problems in the Yard and the methods of control are interesting, our purpose is to consider another phase which is possibly of greater interest to the designer, the owner and operator; namely, the question of the stresses involved. Consideration of stresses may be subdivided in two parts: first, thermal stresses during the welding operation; and second, residual or locked-up stress in the completed structure.

In the true sense, thermal stresses during welding is a production problem and one which keeps the Welding Department continually on the alert. It is these thermal stresses which cause welds to crack as they are made, or not infrequently, cause failures in the parent material itself, and which cause weird and sometimes unpredictable changes in shape. To help solve these difficulties, electrode manufacturers are continually working on materials designed to combat such stresses, for an electrode today is much more than a piece of wire covered with a bit of dried mud. Variations in core wire, in the chemical make-up of the coating, in the preparation of those chemicals and in their application to the wire give not only a wide range of physical properties, but determine the behavior of the weld deposit in cooling and corresponding metallurgical results in the parent metal. In addition to protecting molten metal from the atmosphere, which is a primary purpose of the coating, the chemical and physical properties of the deposited metal can be controlled, rates of cooling changed and the behavior of the welded joint both during and after welding altered appreciably.

The sequence of welding and the various methods of welding are carefully worked out to avoid undue stresses or concentrations of stress. Preheat to various temperatures, depending upon circumstances, may be used to reduce thermal stresses or to insure a deposit better adapted to resist them.

Some conception of the stresses which can be caused by temperature can be gained by considering the relation between expansion of a bar of steel when heated, and Young's modulus for the same material. Roughly, raising a piece of steel to 100° C. or 212° F. results in an expansion in length equivalent to the strain imposed by a stress of 40,000 psi. This is equal to or greater than the yield point of mild steel at this comparatively low temperature. Carry this analogy to local heating of a plate—spot heating—where the heated spot is constrained by cold surrounding metal. It is obvious that we do not have to introduce molten weld metal to have thermal stresses. Our commonest material—low carbon steel—is most fortunately equipped by nature to stand a great deal of this sort of mistreatment. In fact, too often we overlook the fact that severe stresses are being accommodated by plastic and elastic deformation due to the ductility of this material and its

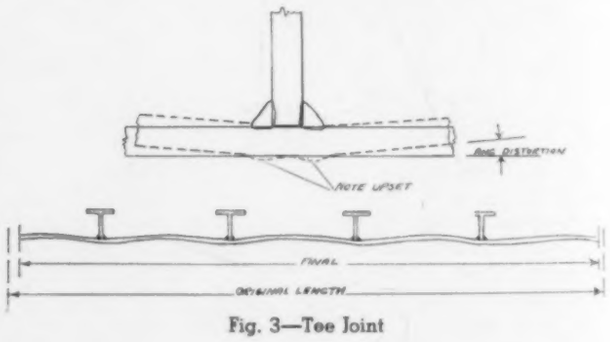


Fig. 3—Tee Joint

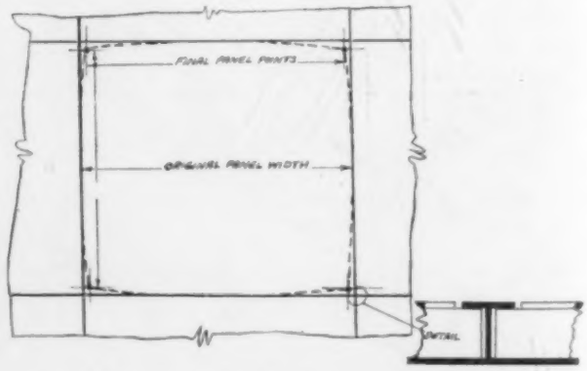


Fig. 4

freedom from hard zones. We become a bit careless, subjecting it to stresses under conditions which do not permit it to distribute the load. Of these conditions, two are of primary importance:

1. Points of high stress concentration; that is, "stress raisers," and
2. Bi-axial or tri-axial stresses.

In the normal course of welding operations, it is quite easy to overlook either or both. Several examples come into mind. Figure 5 shows a comparatively simple assembly of heavy parts. Two arches were to be built consisting of a plate with a U-shaped cut-out stiffened by a heavy flange. The plating was ordered in a size which provided for two arches and in the interests of maintaining alignment, it was decided to leave it in one piece until the face plates had been welded. Since the flat bars for the face plates were received in two pieces and there was no necessity for a butt weld between them, only enough weld metal was placed at the root of each butt to hold the parts in alignment and to provide for the passage of the automatic welding machine. The ends and one side of this assembly were welded without difficulty. While making the weld on the second side, the opposite side of the assembly broke at the point shown on Fig. 5. In this assembly, we were dealing with comparatively heavy parts and the welding which

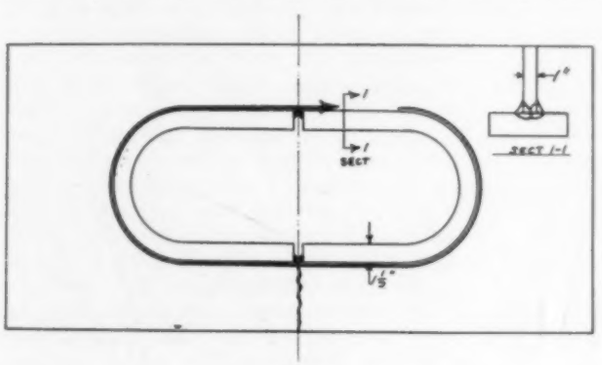


Fig. 5

had been completed had made the assembly exceedingly stiff. The tremendous heat developed by the automatic machine had simply caused expansion on the side being welded. The opposite side was rigid but a perfect stress-raiser was provided by the partly welded butt in the face plates.

Figure 6 shows an entirely different structure but with much the same cause and effect. The 80-lb. plate shown was being welded to the side of the 60-lb. plate, again with an automatic machine. In this connection, these two examples have been taken from automatic machine work only because the penalty for these oversights is apt to be exaggerated by virtue of the tremendous currents and heats used. Similar failures have been found in work manually welded and can be avoided in the case of the automatically made weld. In Fig. 6, the joint between the face plate shown along the upper edge of the 60-lb. plate had not been connected to the heavy forging, thereby providing a stress-raiser. As the automatic weld progressed some 12 in. past this point, although at least 30 in. below it, expansion of the 60-lb. plate threw a tremendous load on the cold edge and the crack shown in Fig. 6 developed.

Thermal stresses of considerable proportion can come from other sources than the welding arc or a heating torch—sudden changes in atmospheric temperatures—an exceptionally warm day or perhaps several days of

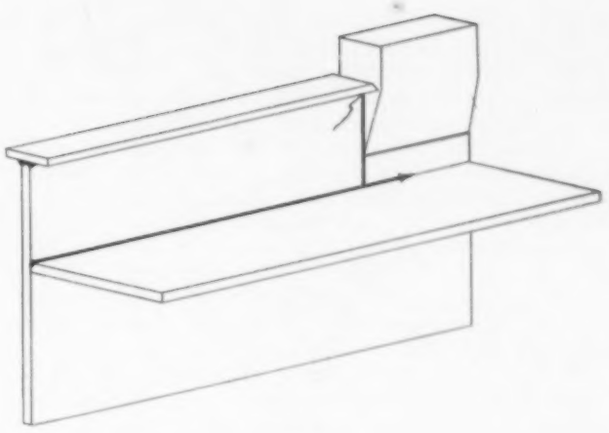


Fig. 6

warm weather with moderate variations, followed by a sudden and severe drop in temperature. Such changes are the cause of infinitely more trouble to the welding department than mere cold itself, providing it remains steadily cold. In my opinion, it is much more important to protect heavy weldments from sudden change than to maintain minimum temperatures of any particular figure. In ship structures, built in the open, we must, of course, take our weather and temperature as we find them. In very heavy parts and on alloy steels, we have learned the value of preheating which is merely another way to protect our deposited metal from sudden chilling and accelerated contraction, as well as to reduce the formation of hard zones in the parent metal. In most ship structure, fortunately, experience indicates little need for elaborate precautions but a combination of adverse factors—change of temperature, points of high concentration and bi-axial restraint—can still result in failures. Figure 7 shows failure which took place in a riveted longitudinal to which a large number of welded attachments are made. The riveted connections to shell and innerbottom are completed prior to the attachment of floors by welding. The web plates, therefore, tend to shrink whereas the top and bottom angles do not, the result being that these angles tend to restrict the free shrinkage of the web. In the case illustrated in this figure, the welding in this particular area was completed during moderate weather, followed almost immediately after completion of the job by an unusually sharp change. The crack shown was found shortly thereafter and appears to be a combination of the three

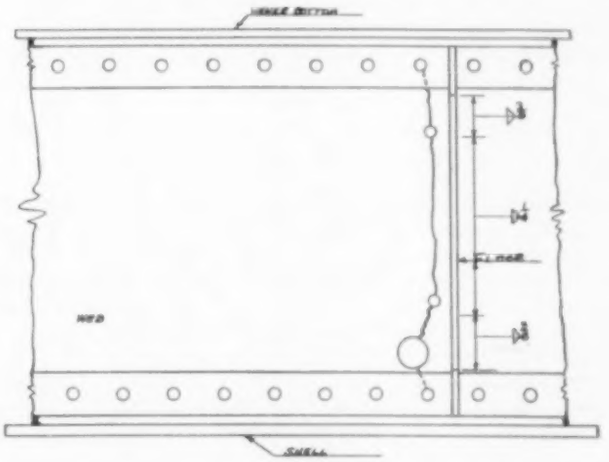


Fig. 7

adverse factors referred to. The question of restraint and possible bi-axial stresses will be referred to again; certainly in this case, the inadvertent location of temporary erection on the same side as the drain hole created the necessary concentration to cause failure.

Let us assume, however, that the welded structure has been completed and is crack-free; and further, has been held within the specified limits of dimension and shape. What then, have we in the way of residual stresses, or "lock-up stresses" since that term seems to be much more descriptive? Have we escaped trouble, that is, cracks and failure, by a margin of a few hundred pounds of stress and therefore are we depending upon a structure which will fail under the first service load?

Many welding specifications still contain the phrase, "Locked-up stresses shall be reduced or kept to a minimum by a sequence of welding which permits parts to shrink freely." As a result of this requirement, once almost universal, a considerable amount of work was done in developing so-called "stress-free" procedures in ship erection and welding. In theory this sounds quite possible but it is exceedingly hard to carry out in practice. Such procedures are based upon a single starting point with successive assembly and welding with every piece available and ready to be welded in that sequence. In combinations of riveted and welded structures, which are still common and apt to continue to be used in the more complicated ship designs, the necessity for completing welding before riveting is particularly plaguing. Note that this does not refer to welding and riveting in the same joint, but to composite structures wherein some connections are welded while others are riveted. It is necessary to digress on this point.

While it has been stated that 90% of our problems in welded construction spring from the necessity of recognizing and compensating for shrinkage and distortion, the rest of the difficulty comes from the mere mechanics of hooking on and temporarily holding parts in place. Theoretically, welded construction dispenses with all holes but without these holes, it is necessary to use clips, "gadgets" or perhaps temporary holes which must be filled up later. Secondly, the regulation of parts into their proper position involves working from scribe lines and pitching spots or again, the use of temporary clips and gadgets. By the use of some riveted joints, we provide the holes necessary for many of these functions and at least during the transition period from riveted to welded ships, we are convinced that we gain most of the advantages of welding with a minimum of its disadvantages and thereby build ships faster than in either the all-welded or the all-riveted design alone. It may also be pointed out that in a yard with considerable riveting equipment and labor skilled in riveted construction available, it is well to use these to the best advantage. We need everything we have in times like these

If each part is free to shrink or more independently of contiguous parts and we religiously avoid all "locked-up" joints, it becomes impossible to have holes in both members, impracticable to have several starting points, or to skip areas in way of alterations or missing material. From sheer necessity to eliminate such hobbles, closer examination was given to this question of locked-up stress. In the first place, there seemed grounds for doubt that the most carefully worked out procedure produced stress-free joints.

There has been a considerable volume of test data published in recent years on shrinkage stresses in the vicinity of welded joints of various types. Examination of these reports leads to the conclusion that the stress distribution in and near a welded joint is exceedingly complicated and indeterminate. Due to the nature of the process, involving high temperatures, there is plastic flow as well as elastic movement in adjacent parent metal. Time and temperature relations are affected by a large number of variables, some completely beyond the control of the operator, and others which vary widely with different operators. In most ship-welding processes, the filler metal is added literally drop by drop with that first deposited cooling more or less rapidly. Even in the highest speed automatic processes, with the possible exception of flash welding which is not applicable to ship joints in general, a large part of any welded joint has time to cool before completion of that joint and obviously supplies a high degree of restraint. Therefore, we may expect to find, as reliable investigations substantiate, the fact that high residual stresses exist irrespective of any external restraint.

From the purely practical standpoint, it may be pointed out that welded joints in large, and frequently complicated ship structures, can rarely be made under conditions which permit the uniformity of shrinkage, irrespective of any external restraint, that has been so frequently assumed. It can also be stated that such structures cannot be erected, regulated and prepared for welding without an indeterminate degree of restraint. Regardless of the methods employed, it is a matter of practical experience that few structures approach the degree of freedom assumed in theoretical discussions of "stress-free" procedure. To avoid excessive distortion and subsequent straightening, considerable use is made of the step-back, extensive wandering and berth systems of welding. It cannot be argued that these procedures, especially the latter two, permit the freedom of relative shrinkage which is assumed. The use of tack welding and bolting, as actually carried out in practical shipbuilding, also denies such freedom of relative movement. In theory, the tack welds are kept small so that if undue stress builds up, the tacks will break and free the members. It is obvious that alignment will also be lost, and equally obvious to any shipbuilder that regardless of rules, laws or written directions, the next time that fitter will see to it that his tacks are strong enough to hold.

Finally, the distortion that accompanies free movement of parts usually requires correction. Of these, on plates, at least, the most common are shrinkage methods. It appears somewhat illogical to take elaborate precautions to prevent or reduce locked-up stresses only to employ means of fairing finished structure which depend for their effectiveness in setting up residual stress.

An interesting and rather informative full-scale test* was carried out at New York Ship a few years ago which has direct bearing on several of the points just mentioned. To check the efficacy of keeping parts entirely free to move, and the relative stresses in identical work in which riveting preceded welding, stress measurements were carried out on a ship's double bottom structure. Three locations were chosen, and in all essential respects were identical. In each case the longitudinal consisted of a web plate, with top and bottom single angles which completed the riveted connection to the shell and innerbottom. Intercostal transverse floors were connected by fillet welds to both sides of the longitudinal web at 4-ft. frame stations. Note that no butt welds are involved—we are noting the effects of fillet welds on a passing or continuous member. Also in these tests, it was first established that the rivets were

* Test directed by Commander W. P. Roop (CC) U.S.N. and data taken by personnel of the Model Basin, from whose report the conclusions are taken verbatim.

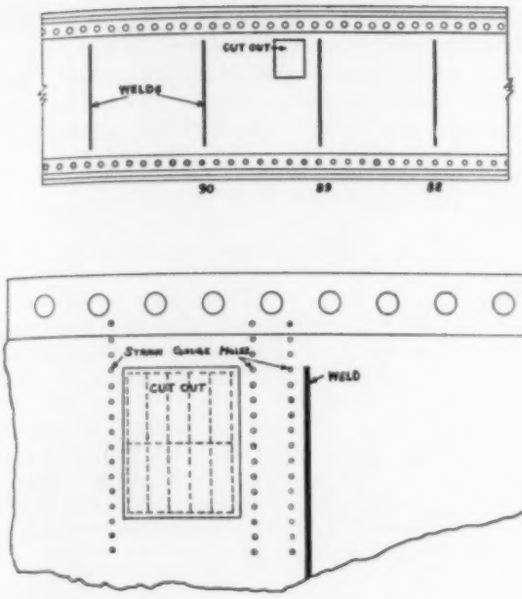


Fig. 8

undamaged, in so far as the careful inspection of removal of rivets from similar connections revealed. Hence, the connections were deemed to be adequate and the stress study was confined to the residual stresses in the web plate.

At one station, Frame 68, all work had been completed for some weeks, the sequence of work being the driving of rivets, followed by welding of the floors. At this station, the strain-gage holes were laid out in the standard pattern adopted for all three tests and initial points measured, Fig. 8. A piece of plate was then removed by drilling and sawing, as shown by the photograph, Fig. 9. Strain-gage readings were then repeated to obtain the elastic release of stress due to removal of plate.

At Frame 89, riveting had been completed but no welding had been done aft of Frame 85, and welding was not complete at all floors aft of Frame 82. To add to rigidity, welding was complete at a W.T. floor at Frame 91 to permit a check of shaft lines. Accordingly, the change in stress was studied by successive readings as welding approached and passed the measuring station.

Neither riveting nor welding had been done aft of Frame 91 so care was taken to see that undersize bolts were used, and all tacks were chipped off. Again, the stresses were measured after each floor was welded. The cut-outs were then removed from both locations and release of stress noted. The results of these hundreds of strain-gage readings are summarized by Table 1. From these, the following conclusions were drawn:

(*a*) Progress of welding toward the observation station causes cumulative strain which is about three times as great at Frame 89, where riveting was complete before welding, as at Frame 94, where constraints against shrinkage were erecting connections only.

(*b*) Strains due to welds more than one frame distant from station are negligible regardless of the nature of the constraint.

(*c*) Strains due to welds at a distance of one frame space are within elastic limits.

(*d*) Strains due to weld at frame immediately adjoining station indicate existence of plastic flow.

(*e*) Such plastic flow exists (though less extensive) at Frame 94, under nominally stress-free conditions, as well as at Frame 89.

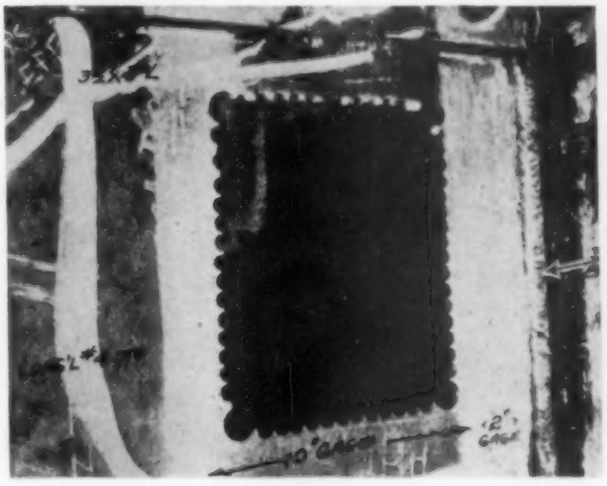


Fig. 9

(*f*) Plastic flow is confined to the metal adjoining the weld, as shown on 2-in. gage lines, and is not found in 10-in. gage lines, distant 3 to 13 in. from the weld.

(*g*) The plastic flow occurs mainly in a region subject to heat effects from the weld, though data do not define the spatial limits.

(*h*) Upon release of load, metal adjoining weld (2-in. base) recovers from strain by about the same amount at all three stations, leaving greatest residual effects at the points where greatest plastic flow had occurred. The same phenomenon occurs in a simple static tensile specimen in which recovery after overstress is the same after any moderate overstress.

(*i*) Data on effect of release on spread of edges of cut-out, as indicated by gage measurements spanning cut-out, are not open to simple interpretation. It is true that absence of spread would indicate absence of residual stress prior to release, but the amount of spread depends not only on the amount of residual stress, but on extent of metal participating in release of stress.

(*j*) In case of stations at Frames 68 and 89, however, conditions with respect to extent of metal concerned and state of constraints at time of release are identical;

Table 1

The results of the strain-gage observations are as follows, the unit of strain being $^1/_{1000}$ in. per inch:

(*a*) Average strain caused by shrinkage against edge constraint due to welds at frames progressively approaching the station:

Station	Gage Length, In.	Welding Extends to Frame 3 Frames	Distant by 1 Frame	At Station	1 Frame Beyond
Frame 89	2	0.00	0.69	5.48	6.72
Full constraint	10	0.03	0.18	0.48	0.64
Frame 94	2	0.03	0.26	1.60	1.72
No constraint	10	0.07	0.09	0.20	0.26

(*b*) Strain release in metal between weld and cut-out:

Frame 68	0.58 unit
Frame 89	0.65 unit
Frame 94	0.63 unit

Comparison may be made with data on 2-in. gage in paragraph (*a*) above.

(*c*) Spread of edges of cut-out due to release of tension (see paragraph (*i*) of Conclusions):

Frame 68	1.79 units
Frame 89	4.34 units
Frame 94	2.21 units

Table 2

The unit is foot-pounds absorbed per cubic inch of metal affected. Distance from weld increases from left to right.

Frame 68:	Upper half	2250	2480	2400	2340	2500	2540
	Lower half	2310	2310	*1780*		2350	2400
Frame 89:	Upper half	2560	2360	2540	2440	2440	2230
	Lower half	2230	2040	*1870*		2210	2540
Frame 94:	Upper half	2580	2420	2420	2500	2560	2480
	Lower half	2730	2420	*2200*		2670	2290

(Underscored values refer to cold-worked metal.)
Check values on unassembled medium steel:

Not cold-worked	2400	2440
Cold-flanged 15°	2190	1750
	1896	2020

the difference consists only in the fact that release at Frame 89 followed immediately after completion of assembly, while at Frame 68 readjustment for a time of about six weeks intervened. The greatly reduced amount of spread of release at Frame 68 is considered to be a consequence of the shaking-down process, vibration, testing, etc.

(*k*) Comparing stations 89 and 94 as to spread on release, it is considered that the higher value at Frame 89 reflects the more severe conditions of constraint at that station. At station 94 spread on release is reduced by the fact that due to lack of constraint the part of the plate aft of the station has no share in the effects of release.

Some work has been done with tensile impact tests and while the results of this test have not been fully correlated with other physical properties, the work done indicates that such tests do indicate the degree of damage done a rolled mild steel plate by cold work (overstressing to the point of permanent set). The cut-out plates were therefore made into tensile impact tests as indicated on Fig. 9. In the lower half, the plate was flanged 30° so that the middle specimen lay in the center of the bend.

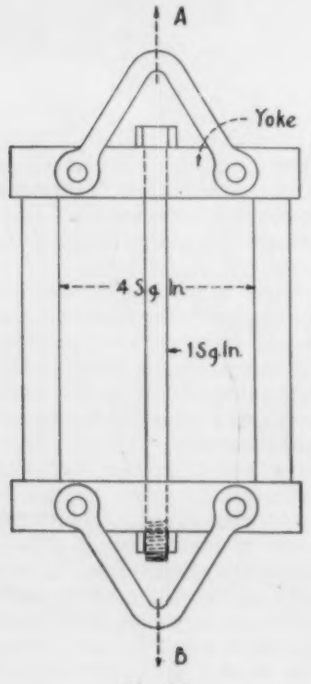


Fig. 10

The results of these tests are summarized in Table 2, from which the following conclusions are drawn:

(*a*) Shrinkage against constraints has caused little or no encroachment on tensile impact value within the area considered and within the limits of error of the measurement.

(*b*) Injurious effects of plastic flow near the weld are localized to the extent that there remains no apparent gradient in impact value beyond the point at which the nearest specimen was taken, about 3 in. from the toe of the fillet.

(*c*) Differences in impact value caused by constraint are slight, but are not inconsistent with the ideas that the greatest degree of constraint causes the greatest loss of impact value and that the effect of time is to relieve rather than increase damage.

(*d*) The cold work involved in a moderate but unobjectionable flanging operation causes a loss of impact value of 15 to 25% of the normal value, whereas losses due to weld shrinkage against constraints are so small that the method would indicate them to be zero, but in any case they do not exceed 5 to 8%.

Fig. 11

The argument in favor of permitting edge constraint against weld shrinkage in longitudinals now presents itself as follows:

(*a*) Plastic flow occurs only locally, not generally; near the welds, and not throughout the plate.

(*b*) Plastic flow occurs near welds even in plates not subject to edge constraint, though its extent may be increased by the constraint.

(*c*) Though plastic flow is known to cause loss of ductility, the amount of this loss caused by constraint is small compared with the loss caused by cold-working operations considered unobjectionable.

(*d*) Effects of plastic flow caused in assembly of the ship are reduced by shake-down.

(*e*) Plastic flow occurs most extensively at the ends of the welds, and in the metal between these ends and the nearest constraints. Its effects can be diminished by suitable practice in this region alone.

Objections to the proposal are:

(*a*) Residual stresses within elastic limits are considerably increased by constraint, and if working stresses are superposed on residual stresses, yield points will be exceeded in service at smaller loads if welding against constraints is permitted.

(*b*) Damage to the metal, though slight, is actually caused by plastic flow due to shrinkage under constraint, and the damage caused by welding without constraint may be already such that to increase it is not admissible, unless, for the sake of other benefits, compensating practices are required.

With the first of these two objections I cannot fully agree, certainly in regard to static loading. In many engineering applications, parts may be given initial stresses deliberately. A bolt in the flange of high-pressure steam lines is one example. In a welded joint or structure the residual stresses compose an internal system of forces which obviously must be in equilibrium. The system as a whole is subjected to external loading in service, and when so loaded, there is not necessarily a simple addition of like forces from which to conclude that some local point may be overstressed. Take, for example, a simple assembly as shown in Fig. 10, which is borrowed from the discussion of residual stresses by S. C. Hollister, Dean of the College of Engineering, Cornell University.* The bolt is tightened until it has a tension of 16,000 lb. on its 1-sq.-in. cross section. The two side posts must have a compression of 8000 lb. each, or 2000 psi. These may now be thought of as residual, or initial, stresses. We know that the frame may stand indefinitely and this stress state will continue.

Suppose now we apply a tension at *A* and *B*, of 9000 lb. Assuming that the yokes do not bend, the posts and bolt are elongated like amounts by the tension. Since the elastic modulus is the same for bolt and posts, this tension reduces the stress in each post to 4000 lb., or 1000 psi., and increases the tension in the bolt to 17,000 psi. If the tension at *A* and *B* is doubled to 18,000 lb., the entire load is taken by the bolt and there is no stress in the posts. Any tension at *A* and *B* in excess of 18,000 lb. will be carried only by the bolt, if the posts bear, but are not attached, at the yokes. Any such tension which does not cause the elastic limit to be exceeded in the bolt, will not alter the residual stress state, since on its removal, the assembly returns to the original state.

When the tension at *A* and *B* was 18,000 lb., there was no stress in the posts, and the total stretch in the bolt was 0.06% due to the 18,000 lb. being carried entirely by the bolt. Suppose, now, the tension is so increased that the elastic limit is exceeded and a permanent set of 0.06% is produced. On release of this load, there would be just contact between yokes and posts, and there would be no stress in either posts or bolt. In this instance, the application of load, after causing a yielding stress in the bolt, resulted in eliminating the residual stress on removal of the load. Stress relief here was obtained by loading. Any process, mechanical or otherwise, which would have produced plastic elongation in the bolt of 0.06% would have achieved the same result on the residual stresses.

There is also considerable evidence from observation and experience which indicated that locked-up stress might not be too important in ship structures, excluding heavy weldments, machined structures, etc., which must have dimensional stability when machined, and which can be and are, carefully stress-relieved in a furnace. Mathar's investigations of "initial" stresses in beams and plate reveal that rolled material, from the mill, contains residual stress ranging from the yield point in tension to the yield point in compression. An indication of these stresses is seen in the behavior of an I-beam when

* Chapter 22, pp. 404–405 of the *Welding Handbook*, published by the American Welding Society, 1938 Edition.

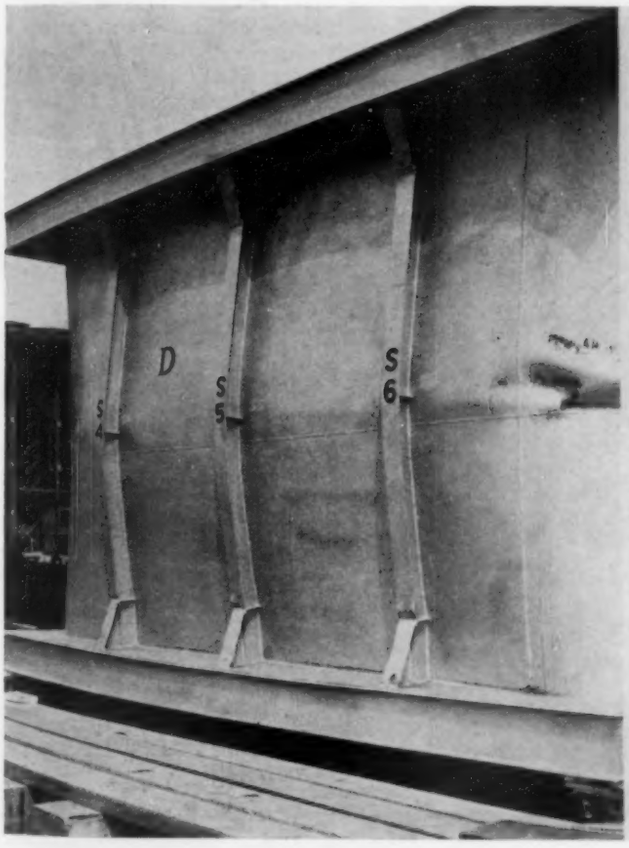


Fig. 12

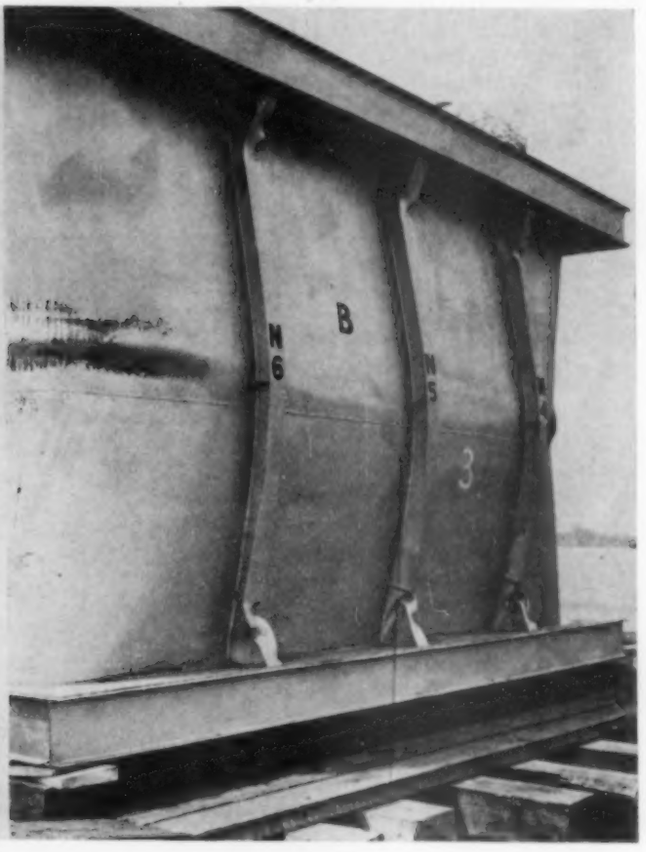


Fig. 13

split longitudinally down the web to form two T-sections. Yet we use these beams safely under the assumptions of our beam formulas.

Moreover, in repair work as well as in major alterations to existing ships, it is impossible to avoid "locked-up" conditions. The vast number of these jobs, ranging from the replacement of a damaged shell plate to the extensive rebuilding of a ship, which have successfully stood up under all manner of service conditions is ample evidence that we depend not upon the elimination of residual stresses but upon the ability of the material to accommodate such stresses.

While the release of residual stress by aging at normal temperatures can be argued with some evidence on both sides, it would appear that overstressing must also be present to accomplish much relief. For example, tires are shrunk on wheels, body bound fits are made in bolts, and so on, indicating that relief from seasoning alone may be slight. However, in the building and launching of a ship, and its first few weeks of service, such local overstressing is going on and through plastic flow—or permanent set, residual stresses most certainly are reduced. Very recently, excerpts from two theses by naval postgraduate students were published in *Marine Engineering and Shipping Review* by Commander H. E. Rossell.* The principle of the relief or reduction of residual stresses by plastic flow, illustrated in the sample test rig, is quite strikingly verified in these experiments.

The conclusions reached by the Subcommittee on Thermal Stresses in Welded Ships of the AMERICAN WELDING SOCIETY, rephrased by Professor Sayre of the Department of Engineering, Union College, were as follows: "*In absence of defective workmanship* residual stresses, whether due to thermal or other causes, become dangerous only if:

1. The material is brittle, with high resistance to plastic flow as compared to its resistance to cohesive failure.
2. The material is in a notch-sensitive state, possibly measurable by unduly low notch impact value.
3. The piece is so thick and so rigid that it maintains its shape even after very high internal stresses have developed. This rigidity prevents plastic flow from occurring, sufficient to relieve these stresses.
4. The stress distribution is such that localized areas of three-dimensional tensile stress can be developed. At these points shearing stress is absent or negligible in amount, and so plastic flow with resulting relief from excessive stress does not occur.
5. Fatigue failures may occur in structures at points of alternating stress. Evidence seems to suggest, however, that in absence of the stress conditions noted in (3) and (4), above, failure will be due to the presence of stress-raisers rather than to the presence of initial stresses."

In conclusion, the effect of suddenly applied loads on structures which are prestressed or which have residual stresses has not been widely investigated in the laboratory, if at all. But it is being checked now in that exhaustive test of service with mines, bombs, torpedoes and shells. Of these tests we hear little, but that little is good. However, in connection with recent tests on structural connections, we have evidence of the explosion resistance of mild steel structure. Figure 11 shows a tank similar in construction to a compartment, open at top, in which explosive charges were fired with the tank filled with water. In this structure, all-welded, usual slab assembly and erection and welding practice were used. Although nothing was particularly rigid, or locked-up, we have noted that residual stresses are present in the material adjacent to all welds. I submit that the condition of this tank, Figs. 12 and 13, which is still tight at every seam and boundary, is some reassurance of the safety of the method, and additional evidence that locked-up stress, while real, is not a hazard in ship structure.

The author has referred frequently to, and quoted parts from, the report of the Subcommittee on Thermal Stresses in Welded Ship Construction, Committee on Marine Construction of the AMERICAN WELDING SOCIETY. This report was published in full in THE WELDING JOURNAL, September 1941.

* *Marine Engineering and Shipping Review*, February 1942, p. 101. Test data and figures from thesis: (*a*) Investigation of the Effect of Fabrication sequence on the Strength of a Typical Riveted Welded Joint by F. G. Springer and P. B. Moore, (*b*) Tensile Stress Distribution Around an Access Hole by J. M. Ballinger and J. A. Obermeyer.

What Happens When You Weld Steel?

By P. E. Timmerman*

MOST experienced welding operators know that when steel is heated to a melting temperature and cooled, as in welding, it undergoes certain changes. These changes may include a gas-producing reaction between certain elements in the molten steel, formation of scale on the surface, over-all expansion and contraction, and changes in the steel's grain structure. By understanding these changes, however, and by using correct welding procedures and materials, the welding operator can readily protect the steel from any harmful effects of these changes or reduce them to a satisfactory minimum.

Important factors that contribute to a good knowledge of welding, from a metallurgical viewpoint, include an understanding of such subjects as the effect of alloying elements in the welding rod, the effect of various flame adjustments, the nature of expansion and contraction, and the relation between heating and cooling rates and the internal physical structure of the steel. Each of these factors will be discussed briefly in the following paragraph.

Alloying Elements in Welding Rods

High-strength steel welding rods contain silicon and manganese, the elements on which the steel manufacturer relies for the production of high-grade steel. By the addition of silicon and manganese to the welding rod, the gas-forming reaction between iron oxide and carbon that would occur during welding is minimized and is replaced by a reaction between iron oxide and the silicon and manganese in the rod. Since the products of this reaction are solids rather than gases, they do not produce blowholes. Instead, when there is a proper relation between the silicon and manganese contents of the rod, these solids produce a fluid slag which will float to the surface of the metal during welding, effectively cleaning the weld metal as it does so and helping to blanket it against further oxidation from oxygen in the air. Eliminating the causes of carbon-iron oxide reactions in this manner makes it possible to increase the carbon content of the rod safely, and thus obtain stronger and sounder welds.

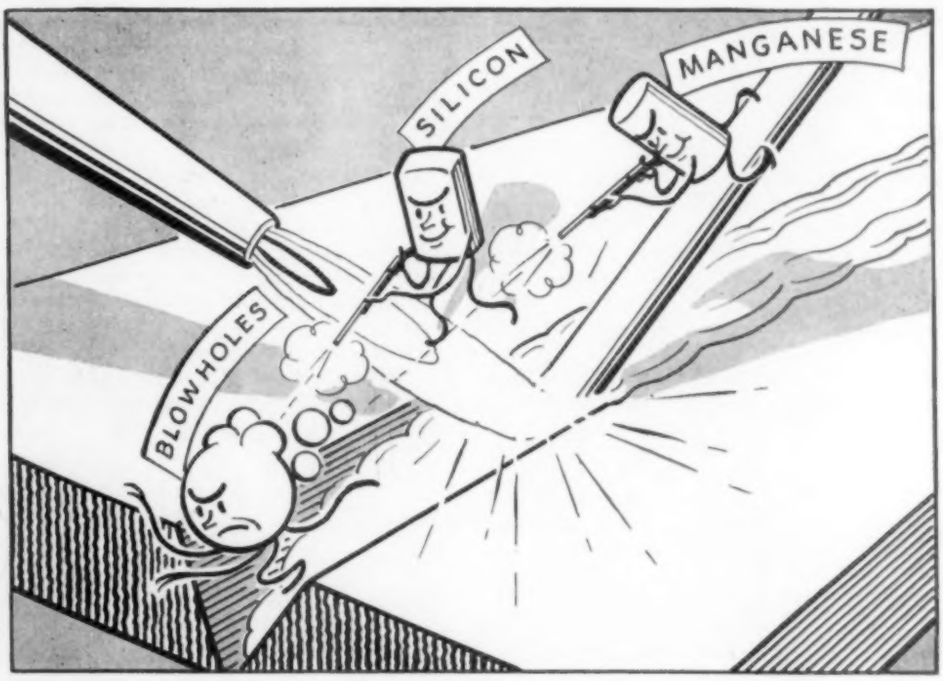
* The Linde Air Products Co., Newark, N. J.

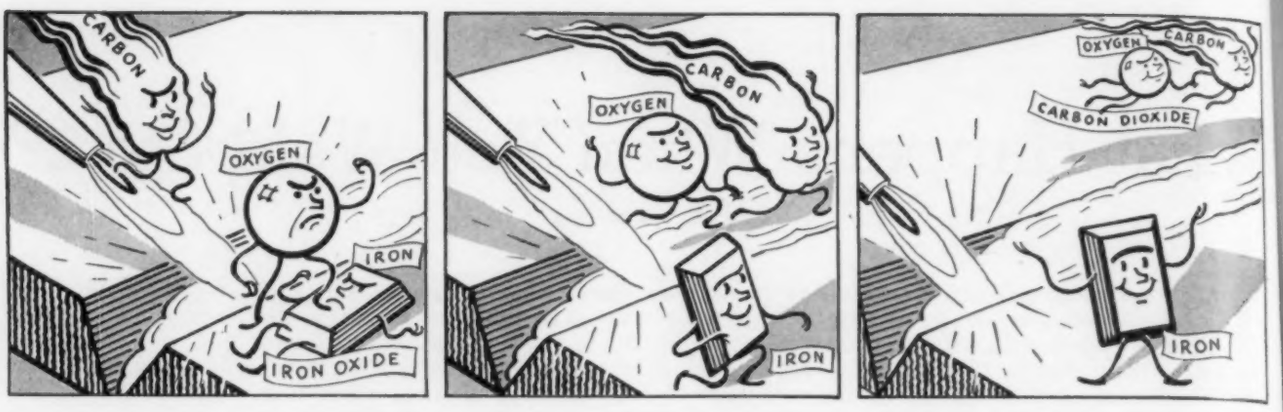
The Welding Flame

By varying the amounts of oxygen and acetylene that are supplied to the welding flame, three different types of flames can be produced: a neutral flame, an excess acetylene (carburizing) flame or an excess oxygen (oxidizing) flame. The oxidizing flame is never used in welding steel because it promotes the formation of iron oxide, which is undesirable.

The neutral flame—produced by a balanced mixture of oxygen and acetylene—is the flame usually employed, since it has the least effect upon the chemical composition of the weld metal. Like the slag floating on top of the

Blowholes Are Largely Eliminated When Welding Rods Contain Silicon and Manganese as Alloying Elements





The Carbon in an Excess Acetylene Flame Effectively Removes Oxygen from any Iron Oxide That May Be Present in the Surface of the Steel

molten metal, it serves to shut out the oxygen of the surrounding air.

The excess acetylene flame is also used because of the development of the special technique of welding in which the welding flame performs an added function over the usual preheating of the base metal and melting of the rod. This welding method depends for its effectiveness upon the fact that the carbon in the excess acetylene flame effectively reduces any iron oxide on the surface of the steel, leaving a type of iron which absorbs carbon from the flame. By increasing the carbon content of the steel in this manner, its melting point is correspondingly lowered.

In the above method the flame is directed backward over the completed weld, but in such a way that it also touches the scarf or vee in advance of the welding puddle. The procedure thus serves to remove rapidly the gas-producing oxide scale in advance of the welding puddle, and to bring the highly carburized, low-melting-point surface of the scarf easily to a "wetting" condition, which is ideal for forming the union between liquid metal from the rod and the base metal. The highly carburized surface of the scarf is rapidly absorbed by the added metal and the carbon diffused through the weld, giving a uniformly strong, ductile weld.

Expansion and Contraction

The simplest phenomenon that happens to solid steel on heating is, of course, expansion. At the time that it is expanding, the steel becomes increasingly soft, ductile and weak, a fact that presents both advantages and disadvantages. As an advantage, stresses in the steel are relieved because of the ease with which the steel can stretch and yield. This is particularly true in oxy-acetylene welding, where a considerable area is heated at one time.

On the other hand, the low strength of the steel at high temperature makes it necessary to be sure that the part is free to move so that an undue load is not placed on the hot steel. For this reason, welding jigs should be more positioning and supporting devices than rigid clamps. Particular attention also should be paid to final welds of a closed structure to prevent locking up of stresses in the structure that in extreme instances might rupture the metal. Preheating is often helpful to spread the heat over large areas or to compensate for differences in mass of the parts being joined.

Effect of Heating and Cooling

In general, welded parts should be allowed to cool slowly for the following reasons. When plain carbon steel is heated to a temperature in the neighborhood of 1600° F., depending upon the carbon content of the steel, it undergoes a change of the utmost importance. At this bright red temperature, the carbon in steel, which at a lower temperature has existed as particles of iron carbide mixed throughout the pure iron, goes into solid solution with the iron. On slow cooling down through this temperature, the carbon is again precipitated or thrown out of solution as iron carbide. The manner in which the precipitation takes place and hence the condition of the steel at lower temperatures is profoundly affected by the rate at which cooling takes place. When rapidly cooled, the steel is left in a relatively hard and brittle condition, whereas when it is slowly cooled through this temperature, it is soft and ductile.

There is another metallurgical change which takes place at about the same temperature. When heated much above approximately 1600° F., again depending upon the carbon content of the steel, the grains tend to grow in size—the size depending primarily on the temperature to which the steel is raised and also on the length of time that it is held at that temperature. If, however, the temperature is raised to just above this point and the time kept short, small grains will be formed, a condition that generally produces superior physical properties.

NEMA Standardization of Resistance Weld and Sequence Timers

By F. H. Roby*

STANDARDS for the performance of eighteen different types of weld and sequence timers have now been established by the National Electrical Manufacturers' Association. This number is sufficient to satisfy the majority of requirements associated with manually operated, motor-driven and air-operated resistance-welding machines.

Process

An understanding of the process is a necessary basis for the discussion of either weld or sequence timers. A resistance weld is made by pressing the work pieces together between two electrodes and passing a high value of current through them. Heat generated at point *B* (Fig. 1) reduces the metal to a plastic state, and the pressure applied induces fusion. The heat available for making the weld is proportional to the product of three factors: welding current squared, resistance of the contact (*B*) between the sheets, and the time during which current is allowed to flow.

Resistance at points *A*, *B* and *C* is inversely proportional to pressure applied. To make the resistance at points *A* and *C low* as compared to that at *B*, considerable pressure must be applied *before* current is allowed to flow. Otherwise, excessive heat generated at points *A* and *C* would burn the work surfaces and damage the electrodes.

Pressure must be allowed to remain on the work a controllable period of time after current is off, to help conduct away surplus heat as it travels to the work surfaces and also to prevent the weld from breaking apart before it is sufficiently cooled.

The manner in which pressure is applied depends upon the kind of machine used. Electrode motion can be accomplished in three ways: (1) manually, (2) by means of a motor-driven cam and (3) with a pneumatic or hydraulic cylinder. A weld timer is used successfully with all three, but the specific type of timer needed will be determined by the nature of both machine and application.

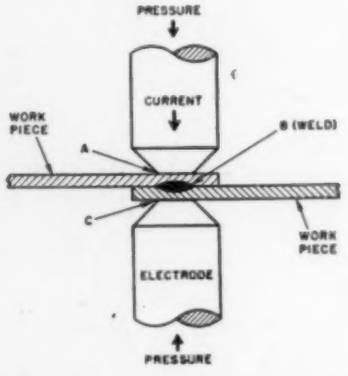


Fig. 1—Pressure Is Required Before Current Flow, to Make Resistance at *B* High Compared to That at *A* and *C*

Fig. 2—NEMA Type 1A Semi-Automatic, Non-Repeat Weld Timer Controlling Only the Weld Time

Weld Timers

A *semi-automatic weld timer* can be used with either manually operated or motor-driven machines (also with air or hydraulically operated machines equipped with a *manually* operated valve). It controls only the duration of current flow through the work in making the resistance weld. Pressure functions must be determined and coordinated by the electrode actuating means. Usually a mechanically or pressure-operated switch, depending upon the kind of machine involved, is used to initiate weld timer operation and thus establish the proper relationship between pressure and power events.

Air-operated machines equipped with electrically operated air valves are made to be fully automatic when supplied with an automatic weld timer which controls not only the duration of current flow through the work pieces but also the order and duration of the several pressure events occurring during the complete resistance welding cycle. They are defined below:

Squeeze Time—The time from application of pressure to the electrode actuating means until application of welding current. Its purpose is to insure that sufficient pressure is on the work before power is applied. A pressure switch can be used instead to accomplish a similar function.

Weld Time—The time that the welding current is applied to the work piece in making a resistance weld.

Hold Time—The time during which pressure is maintained at the electrodes after current is off. The "Hold" period prevents fracture of the weld if the

* Industrial Controller Division, Square D Co.

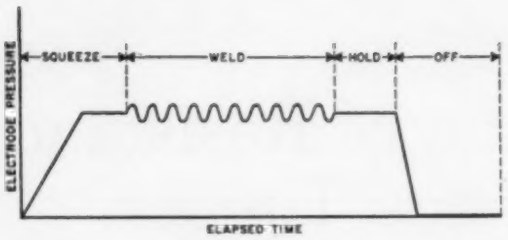


Fig. 3—Pressure and Power Events Making up a Complete Resistance-Welding Cycle

work pieces are stressed and also allows the water-cooled electrodes to conduct away surplus heat as it travels to the surfaces, thereby reducing discoloration immediately adjacent to the weld area.

Off Time—The time (in repeat welding) that the electrodes are separated from the work pieces. This interval gives the operator time to move the work or the welding tool to a new position before the cycle of operation is automatically repeated.

The *non-beat feature* is standard on all automatic weld timers. "Non-beat" is a term applied to a method of connection which causes the weld cycle to be carried through to completion, once it has been initiated, regardless of whether the pilot switch remains closed or not. Thus the operator can release the initiating switch without danger of prematurely interrupting the automatic cycle.

Low-voltage control is optional on all weld and sequence timers. By including a 24-volt power supply for the initiating circuit, the operator is protected against the possibility of electrical shock if insulation in the pilot switch should fail.

Pulsation Weld Timers

Pulsation welding is the method of making a single weld where the welding current is interrupted repeatedly while pressure is held on the work pieces. By keeping the water-cooled electrodes on the work surfaces between current impulses, the surplus heat is rapidly conducted away while the temperature is raised at the point of contact between the work pieces where the weld is to be made.

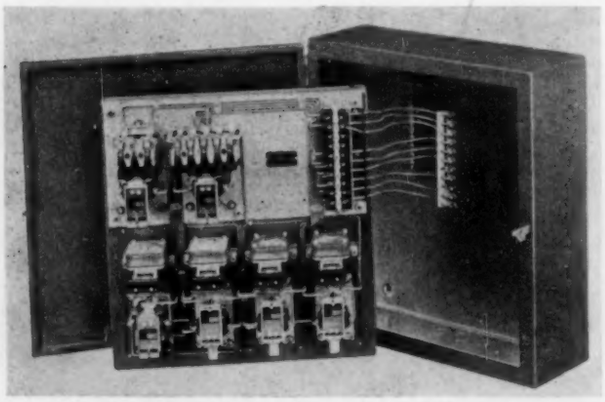


Fig. 4—NEMA Type 3B Automatic, Repeat Weld Timer Controlling Squeeze, Weld, Hold and Off Periods

The "swing-out" panel has been removed to show separable connector and the two relays which operate in connection with timer to energize welding contactor and solenoid valve, respectively. Space for a low-voltage control relay is also provided.

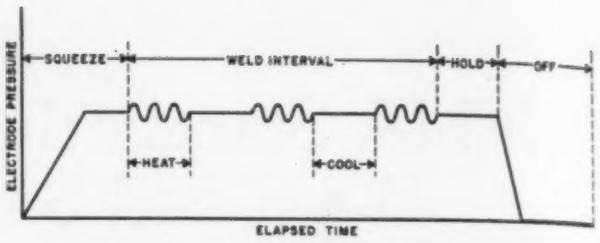


Fig. 5—Pressure and Power Events Making up a Complete Pulsation Resistance-Welding Cycle

The pulsation process makes possible reduction in surface heating, controlled penetration, and tends to more readily break down the insulating effect of scale or other foreign substances on the work surfaces. Repeated power impulses also increase the capacity of a given machine with respect to the thickness of the material to be welded.

Both semi-automatic and automatic pulsation weld timers are included in the standardization. Pressure events involved are the same as those described for weld timers. However, the Weld Time becomes a Weld Interval which is subdivided into a series of Heat and Cool periods occurring in rapid sequence. Definitions follow.

Weld Interval—The total Heat and Cool times (or the total welding period) when welding by the pulsation method.

Heat Time—The time that the welding current flows between interrupted periods when welding by the pulsation method.

Cool Time—The time during which the welding current is interrupted when welding by the pulsation method.

Sequence Timers

A sequence timer is a device for *automatically* controlling only the order and duration of the several *pressure* events occurring during the resistance-welding cycle. Control of time during which current flows through the work pieces is not included, but must be accomplished by some separate means.

Sequence timers are used instead of automatic weld or pulsation weld timers when fully synchronous precision control of either the Weld or Heat times is necessary.

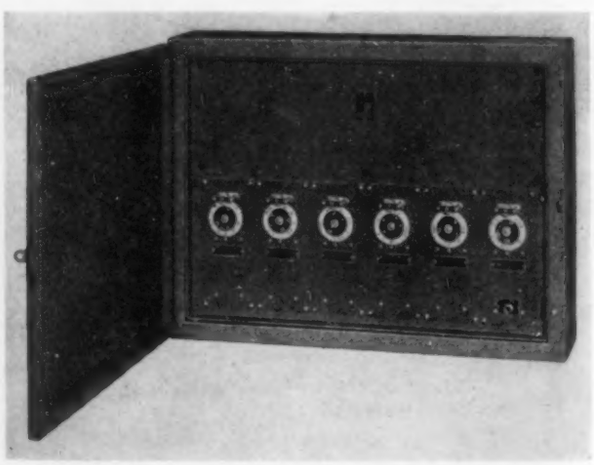


Fig. 6—NEMA Type 5B Automatic, Repeat Pulsation Weld Timer Controlling Squeeze, Weld Interval, Heat, Cool, Hold and Off Periods

NEMA Standards for Resistance Welding Timers

Classification		Weld Timers		Pulsation Weld Timers		Sequence Timers		Pulsation Sequence Timers	
		NEMA No.	Timing Period	NEMA No.	Timing Period	NEMA No.	Timing Period	NEMA No.	Timing Period
Semi-Automatic Non-Repeat	Non-repeat without non-beat feature; for use on manual, air, or motor operated welders having a maintained type initiating switch.	1A	1—Weld	1B	1—Weld Interval 2—Heat 3—Cool				
Automatic Non-Repeat	Non-repeat, non-beat; for use on air operated welding machines controlled from electrically operated air valves.	2A	1—Weld 2—Hold	4A	1—Weld Interval 2—Heat 3—Cool 4—Hold	6A	1—Hold	8A	1—Weld Interval 2—Cool 3—Hold
		2B	1—Squeeze 2—Weld 3—Hold	4B	1—Squeeze 2—Weld Interval 3—Heat 4—Cool 5—Hold	6B	1—Squeeze 2—Hold	8B	1—Squeeze 2—Weld Interval 3—Cool 4—Hold
Automatic Repeat	Repeat, non-beat; for use on air operated welding machines controlled from electrically operated air valves.	3A	1—Weld 2—Hold 3—Off	5A	1—Weld Interval 2—Heat 3—Cool 4—Hold 5—Off	7A	1—Hold 2—Off	9A	1—Weld Interval 2—Cool 3—Hold 4—Off
		3B	1—Squeeze 2—Weld 3—Hold 4—Off	5B	1—Squeeze 2—Weld Interval 3—Heat 4—Cool 5—Hold 6—Off	7B	1—Squeeze 2—Hold 3—Off	9B	1—Squeeze 2—Weld Interval 3—Cool 4—Hold 5—Off

A separate weld timer of the semi-automatic type is normally used for that purpose. The sequence timer includes means for interlocking the separate weld timer with the several pressure events controlled in the sequence timer, to insure correct order of progression.

Interlocking of pressure and power functions is normally accomplished by means of a potential relay operated from the voltage impressed across the primary of the welding transformer. It automatically initiates the Hold Time at the conclusion of the Weld Time or Weld Interval.

When the voltage impressed across the transformer primary is varied throughout a considerable range (as in "heat control") or when it is absolutely essential that the electrodes of the welding machine be prevented from parting while *any* welding current is flowing, a current interlocking system should be used. This feature can be obtained with the standard form of sequence timer if a separately enclosed auxiliary panel is interposed between sequence and weld timers.

The current interlocking system fully protects against damage to both electrodes and work, should either one of the power tubes in the weld timer fail to respond properly to their control circuit, as the result of defective equipment.

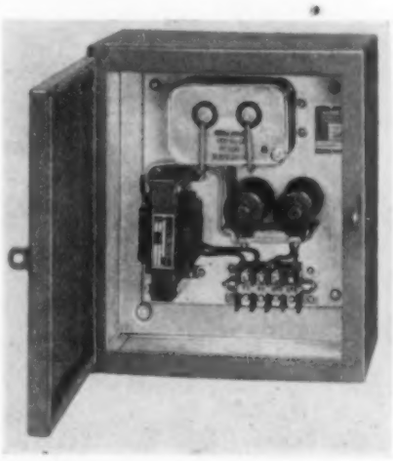


Fig. 7—Auxiliary Current Interlocking Device Used with Standard Sequence Timer to Insure Correct Operation of Interlocking Relay When "Heat Control" Is Involved or When Either One of the Two Power Tubes Fails to Respond to Its Control Circuit, as the Result of Faulty Equipment

Conclusions

Standardization of weld and sequence timer functions benefits the industry by making available at reasonable cost, control units for only those functions actually required. The NEMA type numbers assigned are a convenient reference when comparing devices of different manufacturers.

There remains only for the user to select a construction which in his opinion will result in the greatest installation and maintenance economies and yet will provide convenient, accurate and reliable operation over long periods of time.

What Effect Do Light Rays from Arc Welding or Flame Cutting Have on Eyes?

By H. F. Ingersoll*

THIS question has been asked so often, mistaken and conflicting ideas conceived about it and not often as thoroughly understood or answered as it should be that it is something to which to give serious consideration and attention.

With this thought in mind we may be able to correct some mistaken ideas and eliminate some of the false information connected with it. Perhaps it would be worthwhile to go into this from all the angles encountered by one who has been actively engaged in this work since it came into popular and industrial use.

To begin with it was rather hard to get welders, train them in all forms of welding and cutting and then keep them working at their trade. Promising men would make a start and drop out with eye trouble, others were afraid to give it a try in the belief that there must be something to the eye question and rather than take chances as they thought, just passed it up as something dangerous to their health. It was some time before we went into research on protective lens and the welder at that time was considered a worker taking chances with his health and eyesight.

Let us now consider what caused this wrong impression to gain headway. There are probably more welders today who believe that the actual light affects their eyes than those who know the correct answer, men who have taken time and trouble to protect themselves.

First there is intense heat generated as an arc forms but it is in a small localized area and in most operations easily shielded from the operator and we know he does not burn his eyes from that source.

Next there are sparks emanating from the work being done and considerably varied according to size of particular job being done. We all have been taught safety from sparks and plus good common sense can protect our eyes from this.

Then we arrive at the last and most confusing cause, the light, intense glaring light from the arc and not quite so bright from other operations. There, strangely enough, we discover that it is not the bright glare that we see giving us the trouble but something we cannot see at all and cannot feel taking effect, not until sometime later, generally a matter of hours.

Consider the light spectrum as made up of three separate bands or parts, one composed of ultra-violet rays, one composed of all the colors we see with our eyes and one composed of infra-red rays.

The rays giving out colors and all their shades we see coming from any light source whether it be from a bulb, an arc, flame or sun. What we don't see, cannot see, are the ultra-violet and infra-red rays and here is the catch; they are the ones that do all the damage to unprotected surfaces, your eyes, skin or any part exposed to them—the result, a burn of some degree.

Naturally a person does not want to stare at the sun or any glaring light for any period of time, but normal glances or flashes of any color light as you see it or at a reasonable distance from the source has no more injurious affect on the eyes than looking at a lighted match across the room or at a distant star.

What protection, then, have we from something we know is there but we cannot see?

Most industrial shops engaged in welding have this operation separated from others as far as possible or practical, and fully protecting other workmen by screening or shielding of some sort which we are all familiar with, but very often this is not possible and protection of some sort must be obtained.

To begin with, the operator himself is provided at company expense with a tested lightproof shield, fiber constructed and containing a lens or welding glass, graded in density to meet the varied light conditions. These are in proportion to the work being done; as a rule heavy work goes with brighter light and tapers down to a comparative light shade lens for light work.

In addition he and other workers around him, whether they be welders, helpers or engaged in other work, have glare-absorbing goggles at their disposition for protection against accidental side flashes and reflections. These lens, welding plates and glass have been developed through years of research until they can be relied upon to filter out all injurious and harmful rays 100% and still allow the operator a range of vision suitable to the work he is doing.

Clearing up another mistaken impression, in ordinary daylight these rays that are harmful, at a distance of from thirty to fifty feet are entirely absorbed before they hit your eyes.

Consideration should, of course, be given to these rays when night welding under poor lighting facilities and steps should be taken to warn those engaged.

Let everyone know what the difference is between light or glare from an arc as we *see* it and what actually takes place, and some of our fancied eye trouble from this source and controversy over this subject will be eliminated.

When welding came into popular use a matter of twenty-five years ago there was no such protection available, so what was done about it? The average welder couldn't have told you what was bothering him, let alone the name of the rays. They just knew they were being burned, and blamed the light in general. In fact, there are a great many now who are surprised when this is explained to them, but at that time there was some justification, for adequate protection and information were not to be had.

Common practice was to make a flat wood shield with a handle, a large round hole in the center, collect some red and green glass, generally from railroad switch lamps, put

* Welding Foreman, Fabricating Division, Bethlehem Steel Co.

the two together and there was his shield. I sometimes wonder that we were able to get home after a tough welding job.

I recall some who suffered severe light shock, including myself, requiring medical attention; others, bad burns to the eyes and various parts of face and body similar to severe sunburn, through lack of knowledge, abuse, or perhaps a combination of both, but I have yet to know of one who had his eyesight permanently impaired through this alone. I have no method of determining other than a wide acquaintance with many welders, but I am sure their eyesight will compare favorably after years of welding with that of any given group you may mention and it would not be surprising if it were better.

Having given this more than passing attention throughout the years and personally having experienced most of this trouble, I am convinced that a greater amount of our eye strain is caused not from rays or light glare, unless very careless, but from using dirty or cloudy protective lens, improperly shaded lens for the job we are doing, the constant straining to see through to the focal point of our work. A very little of this goes a long way toward ruining eyesight in any occupation.

Normal light strengthens the eyes and, as stated before, occasional flashes from welders working, while they should be avoided if possible, will no more injure eyesight than flashes of extreme sunlight, the glare of light that sailors and outdoor men are forced to endure, and how many of them do you know with poor eyesight?

Our equipment for protection, such as goggles, welding plates or lenses, hand shields and helmets is very expensive, but it is in our case furnished by the company, thousands spent for it and research work to protect your eyes 100%. Couple this with common sense in safety practice and I will guarantee you will never have to worry about your eyes from any ordinary form of welding or flame cutting.

Application of the Pulsation Welding Process in the Welding of Large Structures*

By O. C. Frederick and R. P. McCants†

THE National Defense Program and the necessity to build things faster, better and cheaper, have focused increasing attention to the various resistance welding processes. This paper deals with the pulsation welding process which is rapidly taking its important place in the resistance welding industry, making entirely practical the spot welding of steel as heavy as two pieces 1 in. thick; and as a result many jobs once considered impractical have been redesigned for resistance production welding.

The development of various alloy electrode materials and the subsequent development of thyratron synchronous control have vastly extended the scope and range of application of the resistance welding process and surely have helped to make possible the development of the many fine welding equipments available today. Likewise it is the authors' belief that the pulsation process vastly extends the range of successful applications of resistance welding, particularly in the welding of heavy gage material, and extends the possibilities of resistance gun welding; however, the use of the pulsation process is not limited to spot welding as it has been successfully applied to seam welding, projection welding and brazing with notable success.

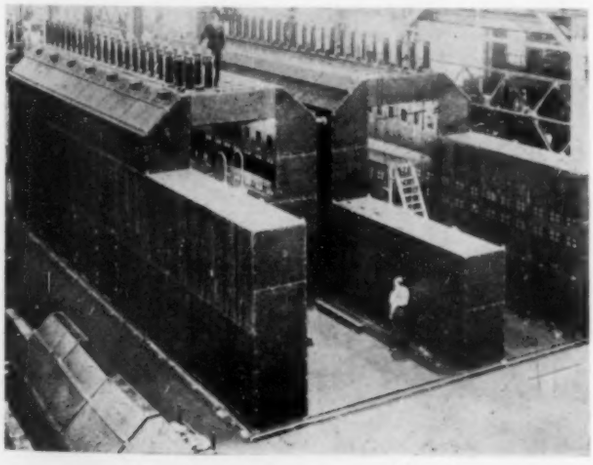


Fig. 1—F. H. Type Cubicle Switchgear Built for a Western Utility Company

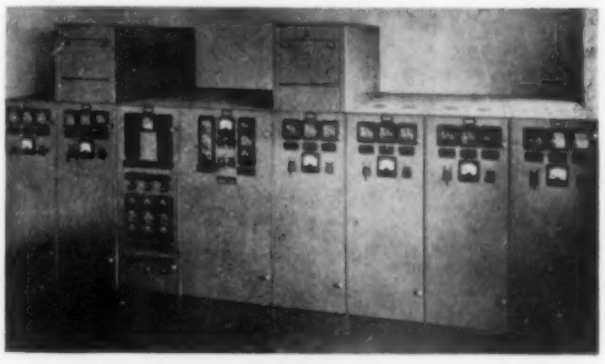


Fig. 2—Metal Clad Switchgear

As time does not permit going into all the details of this process, those interested are referred to the paper presented a year ago by Mr. H. C. Cogan and Mr. R. S. Pelton before this SOCIETY.

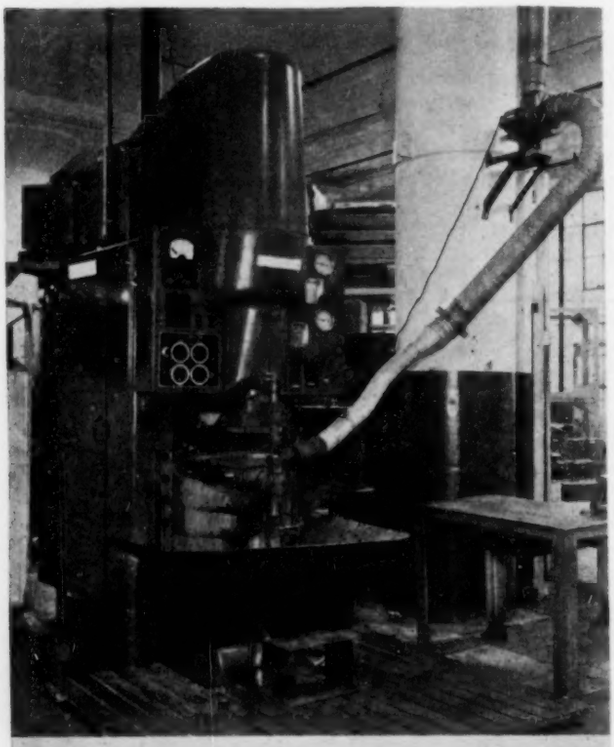
In the manufacture of the heavy structures used in the construction of metal clad switchgear and elsewhere, both machine welding and gun welding are widely employed

* Presented at the Annual Meeting, A.W.S., Philadelphia, Pa., Oct. 20–24 1941.

† Philadelphia Works Lab., General Electric Co.

on steel assemblies ranging upward from two $^1/_8$-in. thick steel sections. These welding machines range in capacity from approximately 200 kva. to 2000 kva. Figures 1 and 2 will serve to indicate the character and size of the structures involved. Figures 3 and 4 illustrate some of the modern welding machines used in the fabrication of these structures.

Fig. 3—Modern 850 Kva. Streamline Press Welder Equipped with Low Inertia Head, Built in Thyratron Control and Air Circuit Breaker



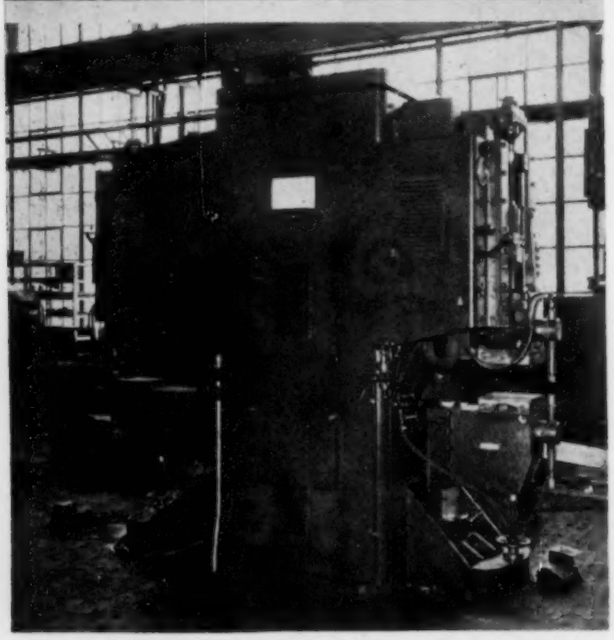


Fig. 4—2000 Kva. Hydraulically Operated Press Welder. Double Ended, with Dual Thyratron Control for Individual Head Action

We had long recognized the many advantages of resistance welding which is especially suitable as a mass production process, and particularly the advantages of gun welding as exemplified by its use in the automotive body industry; however, its limitations precluded its use in construction of heavy structures of highly diversified design until the development of the pulsation process.

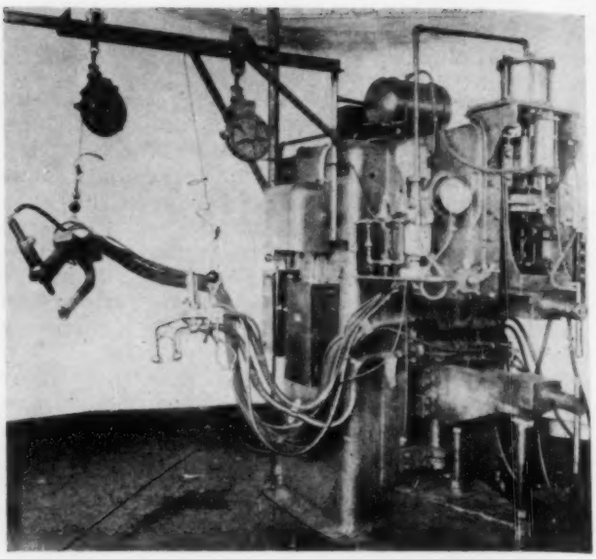


Fig. 5—Press Welder with Portable Guns Attached

Briefly, this process consists of applying synchronous, automatically controlled, intermittent pulsations of current to the work without separating the welding electrodes; for example, in spot welding two pieces $^1/_4$-in. thick with guns we may apply current for 20 cycles *on* 5 cycles *off* for a total of 10 impulses or pulsations. The "off" time in this type of welding cycle allows the water cooling in the electrodes to function and keep the electrodes below the temperature where they upset excessively. Practically all resistance welding facilities in the Philadelphia Works of the General Electric Company

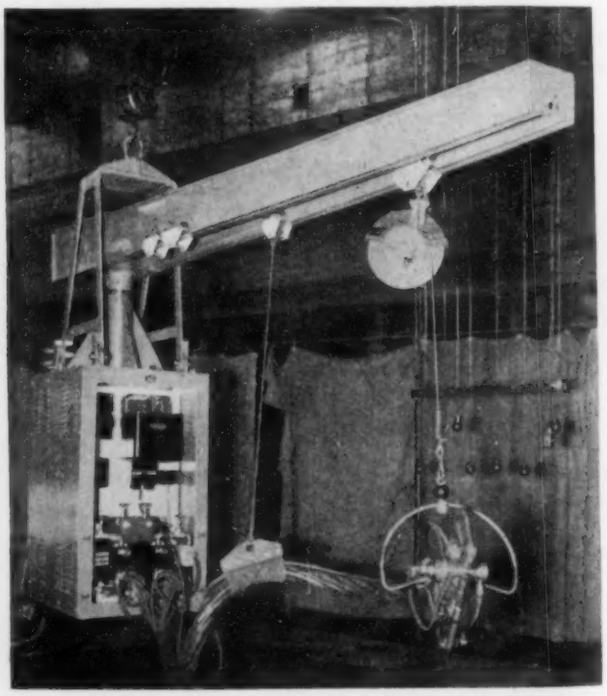


Fig. 6—300 Kva. Portable Welder with Built in Thyratron Control for Pulsation Welding

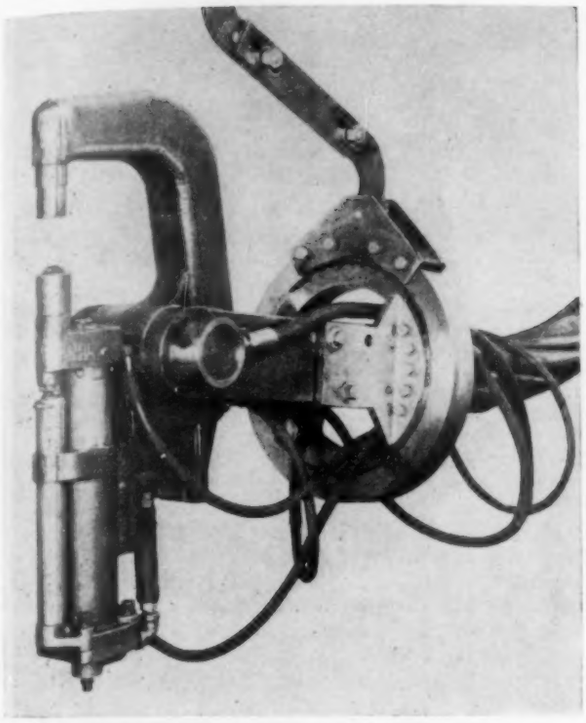


Fig. 7—"C" Type Universal Gun—Hydraulically Operated

are now equipped with thyratron synchronous control for utilization of this process.

In portable gun welding, this "off time" is doubly important as the copper in the secondary circuit, particularly the cables, is inadequate and this condition is aggravated by use of large high capacity guns on heavy stock. In this case we may use 30,000 to 40,000 amp. psi. current density in the cables. The "off time" between impulses and between welds enables the water to satisfactorily cool the cables. For this reason it is necessary that each welding point and each individual cable be separately water cooled; therefore, the pulsation process has made possible the development of flexible high capacity portable spot-welding equipment and relatively light weight welding guns capable of welding heavy sections.

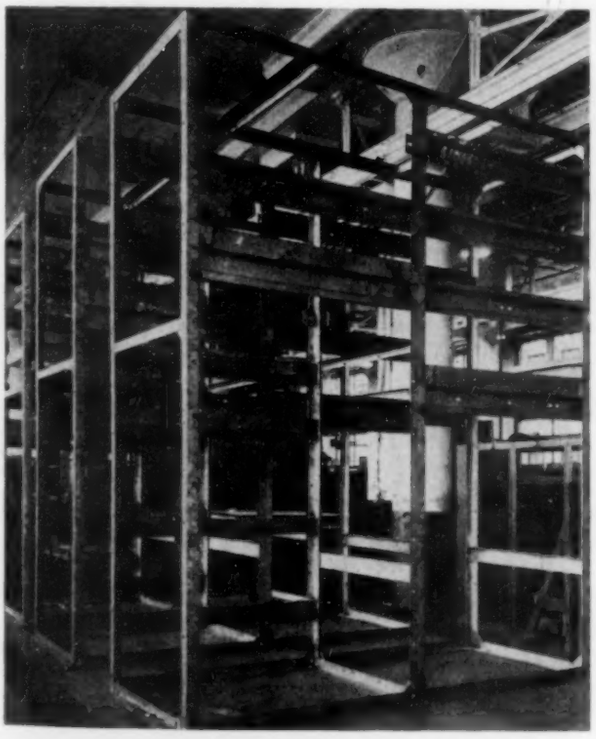


Fig. 8—Framework Type of Structure Fabricated by the Pulsation Welding Process

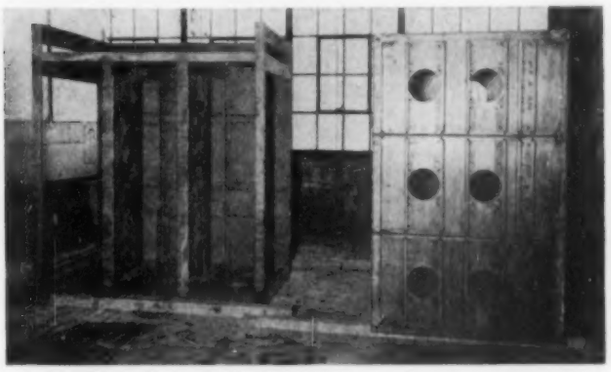


Fig. 9—Skin Stressed Switchgear Cubicle Structures

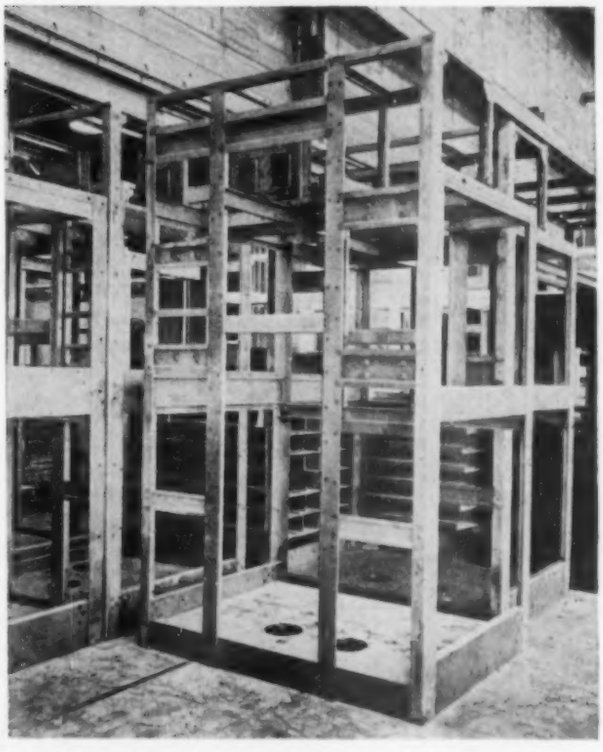


Fig. 10—Framework Type of Structure Made Up Largely of Formed Parts

Application of Resistance Welding Guns

Resistance spot-welding guns have been applied to standard press-type welders as shown in Fig. 5, providing additional flexibility at low cost for particularly such work as subassemblies.

The major application at Philadelphia, however, has been on portable welding equipment involving the fabrication of structures too large and unwieldy to put in a machine.

Figures 6 and 7 illustrate one of these portable welding machines with self-contained boom and a typical gun.

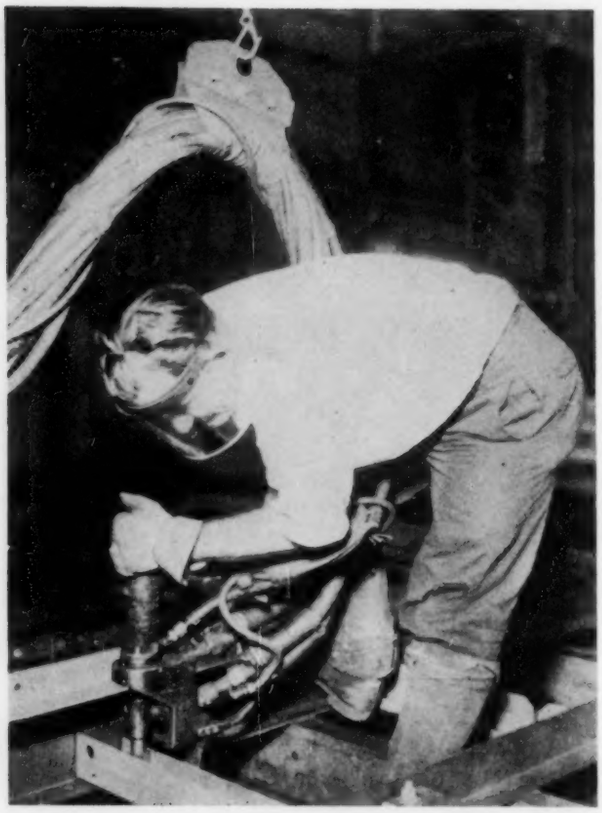


Fig. 11—Closeup of Portable Gun in Use

Types of Resistance Welded Structures

In general two types of structures are being fabricated by the pulsation welding process at our Philadelphia Works.

1. The *framework* type of structure made up of structural steel elements spot and projection welded together to form a strong skeleton to which enclosing plates are bolted, illustrated by Fig. 8.
2. The other type of structure is the so-called skin stressed type which is built up of flanged and formed sheet steel spot welded together. These are illustrated by Fig. 9.

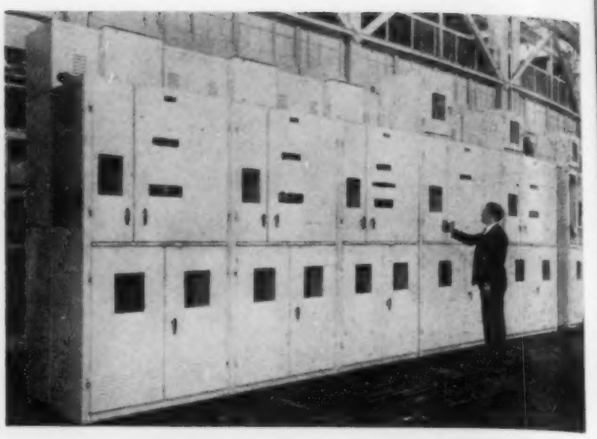


Fig. 13—Completed Switchgear Cubicle Structure Fabricated by the Pulsation Spot Welding Process

Figure 10 shows a framework type of structure which is made up largely of formed sections. The welding of a subassembly of these frames is shown in Fig. 11. Completed structures are shown in Figs. 12 and 13.

It is obvious that in the type of structures and equipment illustrated, weld failures must not occur. The pulsation process, in addition to many other advantages, offers a satisfactory means of *over-welding* to assure good welds under adverse conditions thus assuring very high reliability of weld.

In order to determine the optimum values of current, time, pressure, number of pulsations, etc., a developmental program was undertaken which embraced the determination of:

Fig. 12—Rear View of Assembled Switchgear Cubicle Framework

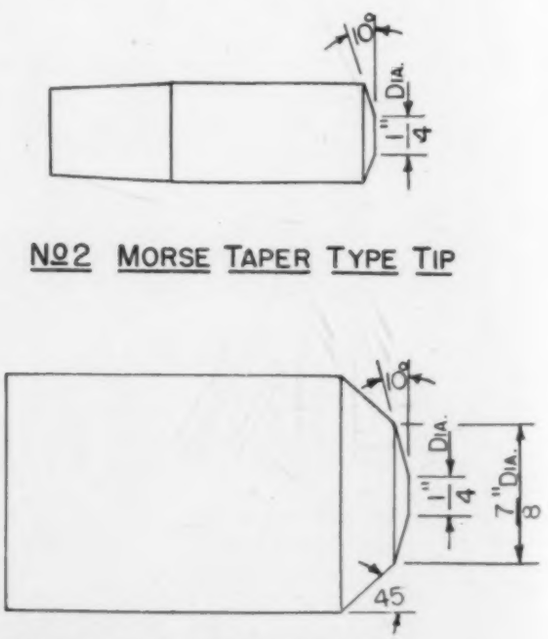


Fig. 14—Spot Welding Electrode Tip Contour

1. The most satisfactory design of welding electrode tip contour.
2. The optimum welding pressure range.
3. The best combination of heating time and cooling time.
4. The optimum number of pulsations required to produce satisfactory welds over a wide range of welding conditions.

Over 5000 combinations of welding variables were investigated, multiplied by a number of grades of low carbon steel and combinations of thicknesses which necessitated the making and testing of many thousands of welds in special testing equipment which was specifically developed for this program.

Figure 14 illustrates the tip contour adopted as a result of these tests.

Design Considerations

It may be of some interest to go into some of the design considerations.

In the fabrication of structures such as switchgear frames, housings, cubicles, etc., particularly large size structures, the changeover to large scale resistance gun welding presents to the designer a problem as to the choice of proper structural shapes and sizes of detail parts used in building up the structure. The parts designed must not only be adequate to perform their physical functions, but must be of such configuration as to permit the full realization of the sizable savings made possible by the pulsation gun welding process. In other words, the design must be such that it fits in with resistance gun welding methods, rather than the methods being devised only to suit the design. In order to fully cooperate with the manufacturing division, the designer must have some means of determining, in the drafting room, what structural shapes and sizes lend themselves to a practical and economical use of the resistance welding guns provided to do the welding job. Obviously it would be extremely wasteful to place in the factory drawings for structures so designed that, when it came time to do the assembly and welding operation, it was found that the welding guns, because of their size, shape, power cables, supporting brackets, etc., could not be economically used.

Scale size sketches and cardboard models of the welding guns are obtained by tracing scale size photographs of the guns which show the general shape of the gun throat, the electrodes, the cables, hose, switches and other obstructions thereon, by manipulating these tracings or models over the scale size structure layout drawing. It is then possible to check to see if sufficient clearances have been provided and if the structural details are adequately planned, all this before release of the drawings to the shop.

Where a number of designers make use of the same gun tracing, any desired number of additional tracings may be made from the original by the Photolitho process.

When new and large complicated structures have been laid out as outlined above, a cardboard scale model is usually made up by the Engineering Department. Then in collaboration with the Welding Engineer and the shop, determination is made as to the size and extent of subassemblies, and such detail changes as may be required for economical manufacture. These models with points of weld indicated thereon assist materially in helping to visualize the correct sequence of assembly to insure accessibility to welding guns.

Welded Hoist

PARTS from seven different makes of automobiles were used in the welded construction of a two-ton tree hoist built by Doc Fixit's Repair Shop of Mt. Vernon, Ohio. Total cost—including time necessary to search for parts—was only $397.

Motor from the ton and a half Dodge truck used for the hoist drives the power take-off. (Shaft, 1929 Chevrolet drive shaft; Whippet universal joint; 1928 Buick spring hangers for drive shaft bearings.) Power take-off drive shaft was connected to a Pontiac transmission with Hudson timing chain and sprocket. Other end of transmission was fitted with the same type of chain connected to the drive sprocket of a Model T truck worm drive.

Left end of the worm drive was fitted with a cable spool wound with 300 ft. of $^{3}/_{8}$-in. soft layed cable. Other end of the drive was connected with a 1923 Hupmobile emergency drum and band—acting as a clutch to raise the load; as brake to lower the load.

Hoist track was welded from 8-in. H columns; legs from 4-in. H columns; braces from 2-in. pipe. A 6 x 6 x $^{1}/_{2}$-in. angle was placed along the rear end of the track bed to distribute the weight of the two rear legs. Carriage was constructed easily from $^{1}/_{2}$-in. plate. Rollers are four 1929 Chevrolet drive shaft bearings. All sheaves are 1929 Chevrolet fan belt pulleys.

Photo courtesy Hobart Brothers Co.

This efficient home-built tree hoist was constructed with Arc Welding Equipment. It is capable of handling two tons. Ratio obtainable in low speed—40 to 1. Original job was contructed for Wade & Gatton Nurseries, Bellsville, Ohio.

Repair Welding in Alaska

By B. L. Crosby

MOST of the welding done on dredges and mining machinery in Alaska is repair and rebuilding. The operating season is from 100 to 150 days, and it also takes about a month to get parts from outside, so we have to keep them turning with what we have at hand. Parts for probable breakdowns are kept in stock, but it often happens that a heavy part or shaft breaks, and then welding is the only answer.

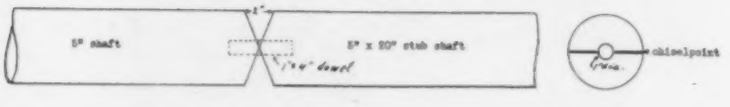
The advantages of oxyacetylene welding and cutting were early seen, and the miners were not slow in exchanging their blacksmith forges for it. It has its limits in heavy welding, especially in heavy shafts, and is usually only used now for cutting. Also, the gases cost about three times as much up here.

About ten years ago, I went to an Alaskan gold field near Nome, with the first arc-welding machine there. At that time, many of the miners distrusted arc welding, but so many impossible repairs have since been accomplished that all the camps have their arc welders now.

Practically all the welding is repair, though some new construction is done. Repairs include structural steel shapes such as digging ladders and spuds; shaft breakage, from large tumbler shafts to small Diesel engine fuel pump shafts; tractors; bulldozers; scrapers; airplane landing gears; manganese steel dredge buckets; and even hot cake griddles.

A new 5-in. shaft was found to be 20 in. too short. A 20-in. piece of shaft 5 in. in diameter was prepared as in Fig. 1. Chisel points were hacksawed out, and by careful welding and peening the shaft was kept true. The line shaft was in its bearings so that it could be rotated as the welding progressed. A cross feed was taken off the lathe and mounted on a fabricated stand to turn the weld to shaft size, as the welded joint was at the end of a babbitted bearing. A $^3/_{16}$-in. bare steel rod—all that was available—was used. This shaft has been in operation for eight years, and the weld is forgotten. (Welds that hold are usually forgotten.)

Fig. 1



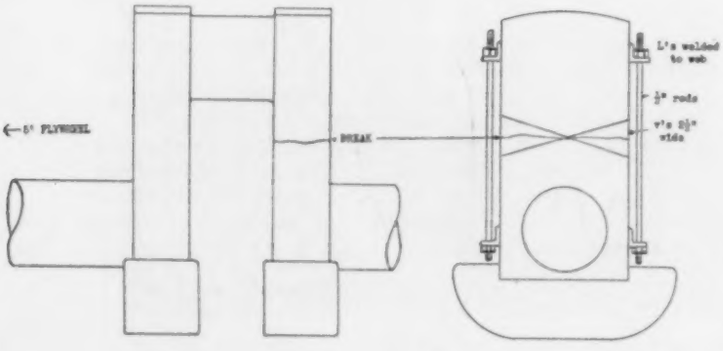


Fig. 2

Fig. 3—Steel Spud

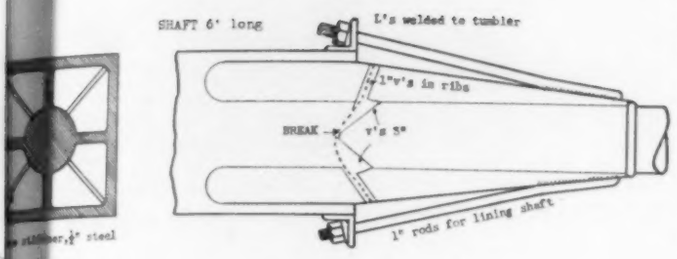
A 5-in. Diesel crankshaft broke across the web. The engine was dismantled, leaving the shaft in its bearings and its 5-ft. flywheel attached. A double V was hacksawed out as in Fig. 2. Trams were set on flywheel rim and forward end of shaft, and the joint lined up and tacked. It was then noticed that the shaft had been sprung in the main journal next to the break. There was nothing we could do about that, so the weld was started. By careful welding and peening, using $^3/_{16}$-in. bare rod, the job was completed in 8 hr. and the flywheel tracked within $^1/_{32}$ in. of true. The engine was put together, leaving the center main bearings slightly looser than usual. It operated under load for four days when a new shaft, flown in from Chicago, arrived and was installed. If it had been possible to put the shaft in a lathe and turn crank pins and journals true, the shaft would have been satisfactory. We have done this on smaller crankshafts that our lathe could handle, and they have stood up fine.

A broken spud was repaired and lengthened, as in Fig. 3. Riveted construction had failed entirely. A new point made from a piece of 8-in. shaft was welded to the worn-out, cast-steel point. This spud has been in use four seasons in the hardest service, holding against a 400-ton dredge, bucking backward 25 times a minute in digging bedrock. A $^1/_4$-in. coated rod was used, and the new point, after shaping with a torch, was coated with manganese steel rod and has resisted wear much better than the original.

An 8-in. cast-steel tumbler shaft broke as in Fig. 4. It was left in its bearings. The break was cut to a chisel point by torch, and the cause was found to be a sand pocket about the size of one's fist. One-inch threaded rods were welded to the ribs of the shaft, and the angle clips welded to the tumbler. By this method the shaft was lined up and could be turned. The weld at the root was with $^3/_{16}$-in. bare rod, as it was impossible to reach in and be sure of getting the slag out had coated electrodes been used. As soon as the weld was fully accessible, $^1/_4$-in. coated electrodes were used. Trams used on the 8-ft. bull gear and tumbler showed little warping, and that was corrected by peening, and the weld completed. Stiffeners cut from $^1/_2$-in. steel plate were welded on as shown in sketch, as this was definitely a poor casting and needed reinforcement. Welding and preparation took about 24 hr., and the tumbler has been in service two years with no signs of failure.

A 10-in. nickel steel tumbler shaft broke as in Fig. 5. It was left in its bearings and lined up as the one above.

Fig. 4



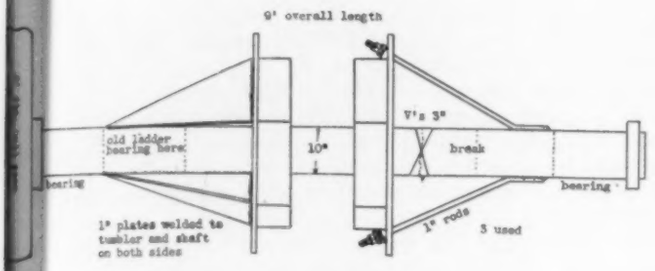


Fig. 5

The cut was veed out with a torch. A large oil torch was then used to heat the shaft to about 200° F. and kept there till the heat of the weld equalled it. The shaft was rotated so that the welds alternated. Constant check on the trams on the bull gear and tumbler, and careful welding, kept the shaft true. Welds were lightly peened with an air hammer. This served to clean off the slag and relieve contraction stresses in the weld metal. Total time for preparation and welding was about 24 hr. One-fourth-inch, heavy-coated steel rod was used at about 250 amp. The shaft has been in heavy service since then and shows no visual signs of failure.

A lattice-type, riveted ladder was loose in every rivet and threatened to buckle. The ladder was removed from the dredge during the winter and laid on the river ice. The old lattice work was cut off and the side girder plates lined up. The angle bars were correctly relocated and tacked to the main plate at intervals of 6 in. The loose rivets were welded around, not for strength but to plug the holes, as steam is used inside the ladder, as rebuilt, to keep ice from forming in cold weather. The lower cast-steel tumbler forks were reinforced and the whole structure lined up. Top and bottom plates were flame cut on the job. Bulkheads were then welded between the side members and the top put on, care being taken to keep the whole structure lined up. The bottom plates were then welded on, making a steam-tight box structure as in Fig. 6. This job was done while the temperature was −30° or less, and $^1/_4$-in. coated electrodes were used. A light, fast bead was laid and the fillet completed as the frost worked out of the metal. There were no long continuous welds allowed, but welds were spaced around to suit conditions. All welds were in down-hand position.

Despite the many troubles of welding in this temperature (helmets would fog and frost up, and exasperate the operators—this was overcome by heating up spare helmets over the radiator of the welding machine), the job was successful and has shown no evidence of failure in the last two years. One feature of repair welding has impressed me; invariably the owners or managers, who have not had much to do with welded structures, insist on too much weld—consequently slowing down the job as well as causing much trouble with warping.

Roller bearing on caterpillar final drive broke, and the cat operated some time before the driver noticed it. The bearing surfaces on the outer end of the shaft and in the hub were ruined. Due to a mistake in ordering, the new parts, when they arrived, were for a narrow instead of a wide gage cat. Both new and old parts were carefully measured for length and parted in a lathe. The sections were set up on a mandrel in the lathe (see Fig. 7). Using a dial indicator and careful welding with $^3/_{16}$-in. stainless rod the pieces were spliced together. The housing was out a trifle under 0.002 in. and the shaft was perfect. The cat has been in operation over two years, welds forgotten as usual.

Our best precision welds were: Building up a worn three-lobed cam in the fuel pump on a Diesel; it was removed from the shaft, set up in a lathe and built up with manganese rod, taking care not to distort a bevel gear $^1/_4$ in. from the cam and integral with part. It was ground to dimension and has given excellent service. The fuel pump shaft on another Diesel broke back of the timing gear bearing. Shaft diameter about 1 in. Ends at break were ground to chisel points and set up for welding. Great care had to be taken to keep the over-all length of the shaft exact and keyways lined up. Welded with $^5/_{32}$-in. stainless rod, peened true and surplus weld ground off.

Manganese steel bucket lips used to be riveted to the buckets and two-thirds of the metal was thrown away when the lips were renewed. By using manganese filler bars, cast to shape and welded to the worn lips with stainless steel rod, we get very fine results—both in operation and cost over the old method.

Broken eyes in these buckets have been successfully welded. The arc is used to vee out the break, and stain-

Fig. 6

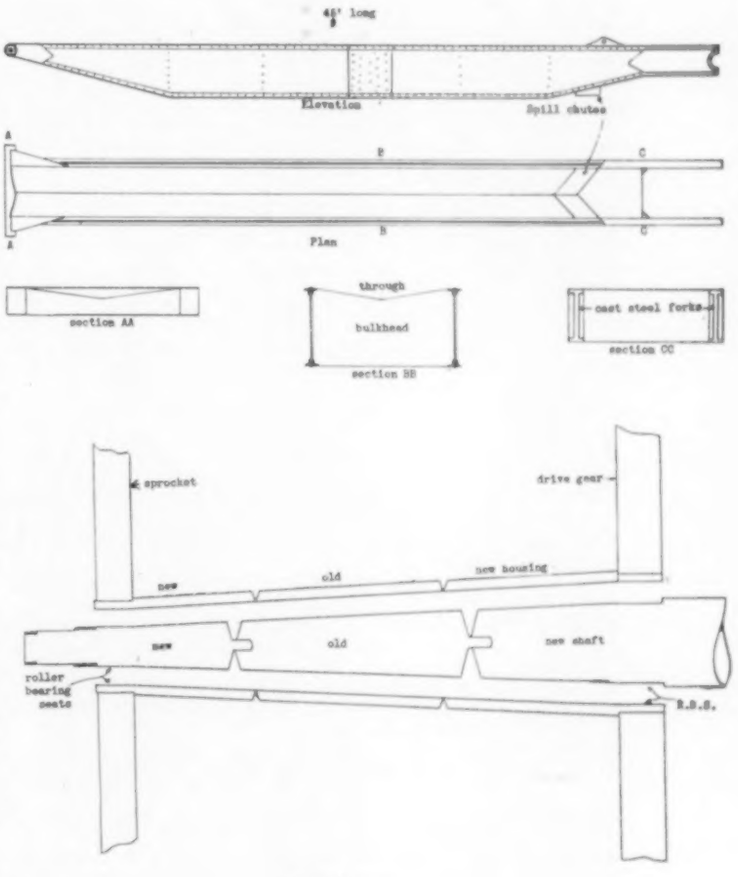


Fig. 7

less steel rod used. Care is taken not to heat the material too much, and peening is resorted to. About 1000 lb. of manganese rod are used per year in building up ladder rollers, tumbler wear plates, cat tracks and other parts that are exposed to abrasive action.

Cast-iron parts that fail are usually junked, as the boys can manufacture a better part out of steel, using the torch and arc. Bronze bushings, gears, etc., are built up by arc welding with a coated bronze rod and machined to dimension.

Our landing fields up here have usually been a gravel bar in the river. Quite often the pilots (and there are none better) have us weld up a broken tail wheel mounting or straighten out a landing gear for them. A Taylor Cub nosed over in taking off and buckled the fuselage under the cabin. While this was not a welding job, we got it flying again. A 17-ton cat was hooked to one end of the fuselage and the other end anchored. By pulling carefully with the cat, while the bent members were heated with the torch, the fuselage was straightened out enough so that the control wires to the tail would function. It was then flown to Nome and correctly repaired there.

In 1936 I had the privilege of being a welding inspector on a 1200-ton combination tug and gasoline tanker that has been in successful operation on the Columbia River since then. This boat was completely welded throughout—not a bolt or rivet anywhere in the hull structure. The hull is $^1/_4$-in plate, and frames, engine beds, etc., were flame cut from suitable steel. A $^3/_{16}$-in. coated rod at 180 amp. was used. The hull was perfect—not a buckle or sag anywhere—though we had some trouble with bulkheads warping. All tanks were tested with a 10-ft. head of water and required to hold it for 8 hr. Very few welds leaked, and they were chipped out and rewelded.

Fig. 8—One of the All Welded Oil Barges on the Columbia River

Twin Diesels of 400 hp. each drive the propellers that turn in tunnels above the bottom line of the boat.

All welded barges are pushed up-river and left at various points while their gasoline or oil is unloaded and wheat or other produce is loaded in the deck houses for the return trip (Fig. 8).

Current Welding Literature

Airplane Manufacture. Aircraft Welding, R. R. Wiese. Product. Eng., vol. 13, no. 2 (Feb. 1942), pp. 119–120.

Airplane Manufacture. Aluminum Aircraft Tanks—Fusion Welding with Oxyacetylene Blowpipe Flame, A. J. T. Eyles. Sheet Metal Inds., vol. 16, no. 177 (Jan. 1942), pp. 89–90.

Ammunition Cases, Welding. Ammunition Cases for Fighter Aircraft, G. Smith. Steel, vol. 110, no. 5 (Feb. 2, 1942), pp. 60, 62 and 64.

Annual Directory Number. Weld. Engr., vol. 27, no. 3 (Mar. 1942), pp. 53–83. Directory of manufacturers of more than 200 products used for welding and cutting, trade names of equipment and accessories with brief definition of product; classified directory of independent jobbers and distributors.

Automobile Maintenance and Repair. Reclamation of Worn or Damaged Parts, W. J. Cumming. Can. Automotive Trade, vol. 24, no. 2 (Feb. 1942), pp. 18–19, 44 and 46.

Automobile Maintenance and Repair. Transportation and Maintenance Sessions. Soc. Automotive Engrs.—J., vol. 50, no. 2 (Feb. 1942), pp. 58–61.

Bridges, Steel. New Tests on Welded Bridge Girders. Ry. Gaz., vol. 75, no. 25 and 26 (Dec. 19, and 26, 1941), pp. 652–653.

Cams. Hard-Facing Cams. Oxy-Acetylene Tips, vol. 21, no. 3 (Mar. 1942), pp. 66–67.

Cars, Freight, Hopper. Reading 55-Ton Hopper Cars. Ry. Mech. Engr., vol. 116, no. 2 (Mar. 1942), pp. 116–121.

Crankshafts. Cast-Iron Crankshafts. Oil Engine, vol. 9, no. 105 (Jan. 1942), pp. 230–231.

Electric Busbars. Brazing Copper Bus Bars. Weld. Engr., vol. 27, no. 3 (Mar. 1942), pp. 34–36.

Electric Motors. Trends in Motor Design and Application, E. W. Henderson. Elec. News, vol. 51, no. 1 (Jan. 1, 1942), pp. 17–19.

Electric Welding, Arc. Conservation of Welding Electrode Vital to War Effort, C. B. Herrick. Industry & Welding, vol. 15, no. 3 (Mar. 1942), pp. 42–48.

Electric Welding, Arc. High-Speed Arc Welding, S. G. P. de Lange and E. S. Waddington. Sheet Metal Inds., vol. 16, no. 178 (Feb. 1942), pp. 224 and 226.

Electric Welding, Arc. Shop Fabrication of Special Tools, A. F. Davis. Petroleum Engr., vol. 13, no. 5 (Feb. 1942), p. 113.

Electric Welding, Arc, Weaving. When, Where and How to Weave, E. W. P. Smith. Steel, vol. 110, no. 6 (Feb. 9, 1942), pp. 76, 79 and 85; no. 7 (Feb. 16, 1942), pp. 72, 74, and 77.

Electric Welding. Electrodes. Welding-Electrode Conservation Vital to War Effort, C. B. Herrick. Oil & Gas Jour., vol. 40, no. 44 (Mar. 12, 1942), pp. 41 and 43.

Electric Welding Machines, Resistance. How Series Capacitors Are Used to Reduce Peak Demands of Resistance-Welding Machines, R. E. Marbury. Steel, vol. 110, no. 8 (Feb. 23, 1942), pp. 88 and 91–92.

Electric-Welding Machines. What Welding Control Where? C. E. Smith. Weld. Engr., vol. 27, no. 4 (Mar. 1942), pp. 27–30.

Electric-Welding Machines. Why Thyratron Control for Resistance Welding? C. E. Wright. Elec. Engr. & Merchandiser, vol. 18, no. 9 (Dec. 15, 1941), pp. 200–204.

Electric Welding. Resistance Welding at International Business Machines Corporation, W. R. Sweet. Industry & Welding, vol. 15, no. 3 (Mar. 1942), pp. 34–35 and 40.

Electric Welding. Resistance Welding—Modern Method of Metal Fabrication, R. T. Gillette. Industry & Welding, vol. 15, no. 3 (Mar. 1942), pp. 36–40.

Electric Welding, Resistance. Spot-Welding Technique for Light Alloys, A. J. T. Eyles. Mech. World, vol. III, no. 2872 (Jan. 16, 1942), pp. 62–63.

Electric Welding. Resistance-Welding Transients, E. E. Kimberly. Elec. Eng., vol. 61, no. 2 (Feb. 1942) (Trans.), pp. 94–95.

Electrodes, Electric Welding, Arc. Conservation in Welding, C. B. Herrick. Weld. Engr., vol. 27, no. 3 (Mar. 1942), pp. 31–33.

Handbooks. Airco Welding Procedures. Air Reduction Sales Co., New York, N. Y., 1941. 54 pp., tables, diagrs., suppl. sheets. 60¢.

Handbooks. Welding Encyclopedia and Welding Industry Buyers' Manual, compiled and edited by L. B. Mackenzie and H. S. Card; re-edited by S. Plumley. 10th ed. Welding Engineer Publishing Co., Chicago, Ill. 712 pp., illus., diagrs., charts, tables. $5.00.

Heat Treatment. Oxyacetylene Flame Hardening—17, J. G. Magrath. Amer. Machinist, vol. 86, no. 5 (Mar. 5, 1942), pp. 178–180; 18, no. 6 (Mar. 19, 1942), pp. 217–219.

Machine Tools, Maintenance and Repair. Repair of War-Damaged Machine Tools by Welding. Machinery (London), vol. 60, no. 1533 (Feb. 26, 1942), pp. 121–123 and 125.

Materials. Condensed Review of Some Recently Developed Materials. Amer. Soc. Naval Engrs.—J., vol. 54, no. 1 (Feb. 1942), 9 suppl. sheets between pp. 84 and 85.

Mercury Vapor Process. New Mercury-Vapor Power Plant, A. R. Smith and E. S. Thompson. Steel, vol. 110, no. 2 (Jan. 12, 1942), pp. 52–53, 84 and 87–88.

Metals Analysis, X-Ray. Use of X-Rays for Non-Destructive Inspection of Metals, R. T. Foreman. Tool & Die J., vol. 7, no. 10 (Jan. 1942), pp. 32–34, 36, 38 and 64.

Metals Cutting, Clamping Devices. Quick-Acting Clamps for

(*Continued on page 330*)

Recent Welded Piping Installations Show Value of New Techniques

By G. G. Landis*

NEW techniques in the arc welding of pipe installations have resulted in greatly increased use of this method in many piping applications.

The method, much more flexible than other procedures, makes easier the solution of problems which arise in laying lines. Because shortages have made it increasingly difficult to obtain special elbows, T-sections, flanged section and anchorages, piping engineers have turned more and more to the versatile electric arc and welded fabrication of these essential parts.

Because of these factors, the city of Cleveland, Ohio, recently specified arc welding in the construction of the new municipal power plant. Six miles of steam piping is involved in the plant, and every joint was welded by means of the electric arc.

Figure 1 shows a welder at work on one of the thousands of joints at the plant. This 8-in. high-pressure pipe was welded with six passes, using modern shielded arc-welding equipment. The joint first was tack welded, and then the first bead was laid carefully so as to avoid burning through.

On successive beads the current was increased to assure complete penetration. The joints are of the U-groove type.

The system is designed to operate at 1850° F. and at a pressure of 650 psi. Arc-welded construction was specified primarily because of the strong connections obtained, but a number of other advantages also contributed to the selection of fabrication by means of the electric arc.

The application of insulation to welded steam pipe is greatly simplified when welding is used, because of the lack of bulky joints. The insulation may be wrapped around a welded joint just as easily as it may be applied to a portion of pipe in which there are no joints. This saves time and money and results in a better looking finished installation.

Large sizes of pipe only increase the advantages of arc welding. Figure 2 shows a workman inspecting a welded joint at the beginning of an expansion loop at the Cleveland power plant. This loop, in the main steam line connection between the new and the old Municipal plants, is of pipe 16 in. in diameter—the largest used in the installation.

Contractors for private power and heating plant installations also are using arc welding more and more as they discover its advantages. More than 6000 ft. of piping for a new power and heating plant in a New York apartment house recently was installed. The installation utilized pipe varying in size from 2 to 12 in. and was all electrically welded with approximately 1400 lb. of electrodes. The working pressure of the steam line is 185 psi. Figure 3 shows a welder completing a weld on a joint.

* Chief Engineer, The Lincoln Electric Co., Cleveland, Ohio.

Accompanying the increase in arc welding of steam systems has been its application to air conditioning systems, dairy use and ventilating ducts.

An eight-story department store in Kansas City, Mo., installed an air conditioning unit which required 3400 ft. of pipe, ranging in size from 10 in. to $1^1/_4$ in.

The regional manager of the firm which constructed the unit found that electric arc welding materially

Fig. 1—Welder Works on High-Pressure Steam Pipe Used in New Cleveland Municipal Power Plant

Six passes of the electrode are made on joints like this, which must withstand pressures up to 650 psi.

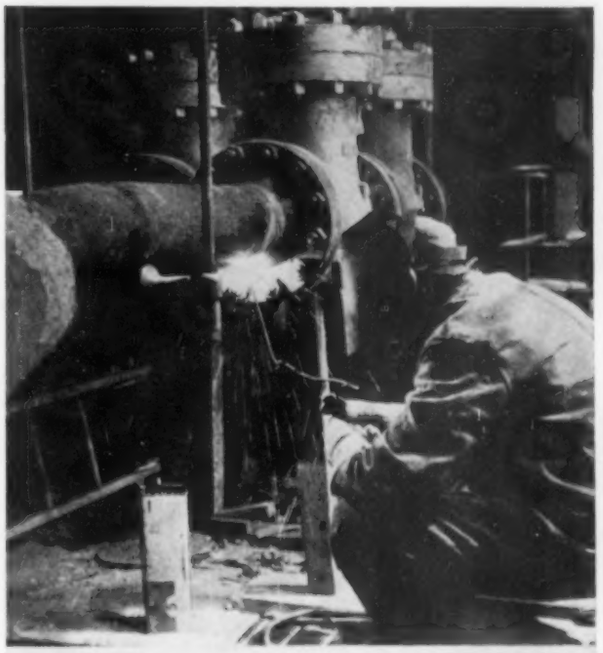


Fig. 2—This 16-In. Pipe Presents No Particular Problem for the Arc Welder

A bulky bolted joint often makes it impossible to run a pipe as near a wall as is desired.

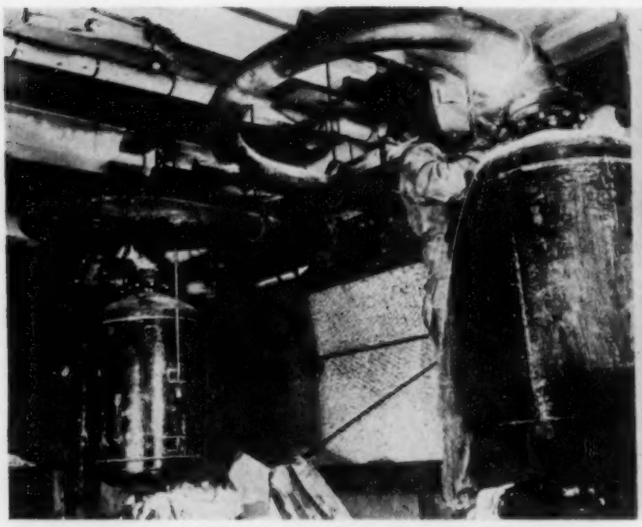


Fig. 3—Welding Saved Time and Money in This Private Apartment Power and Heating Installation

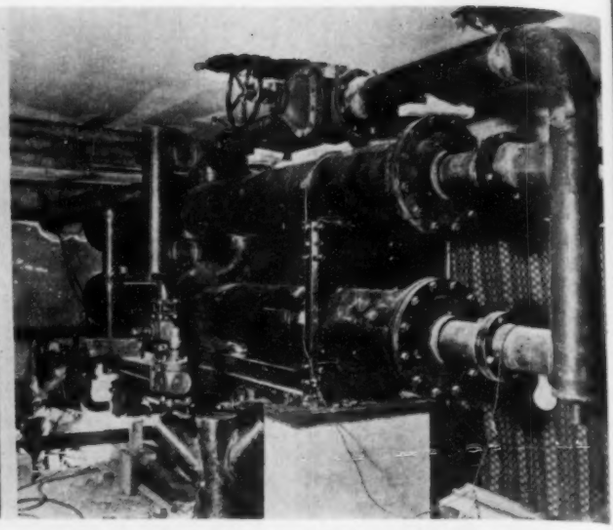


Fig. 4—Air Conditioning Unit Installed in a Department Store at Kansas City, Mo. Arc Welding Was Used Extensively

reduced costs over other methods and other welding systems.

Figure 4 shows a view of air conditioning pipes and in the left background, a welder plying a seam with the electric arc.

A Baltimore, Md., chemical plant installed a system of rubber-lined ducts for the purpose of conveying acid fumes from the factory. The contracting concern found that it could save money and do a better job by using arc welding.

A dairy company, located in Chicago, Ill., found that use of welded tubing for the conveying of milk and other fluids resulted in a great saving. Figure 5 shows stainless steel pipe hangers welded to stainless steel pipe, supporting stainless steel milk piping. The upper piping is entirely welded. The lower, which carries the milk, is joined by threaded couplings to permit periodic cleaning by taking the sections apart.

The company finds that arc-welded installation simplified erection, provided permanently leak-proof connections, saved time and labor for painting and insulation and kept piping costs at a minimum.

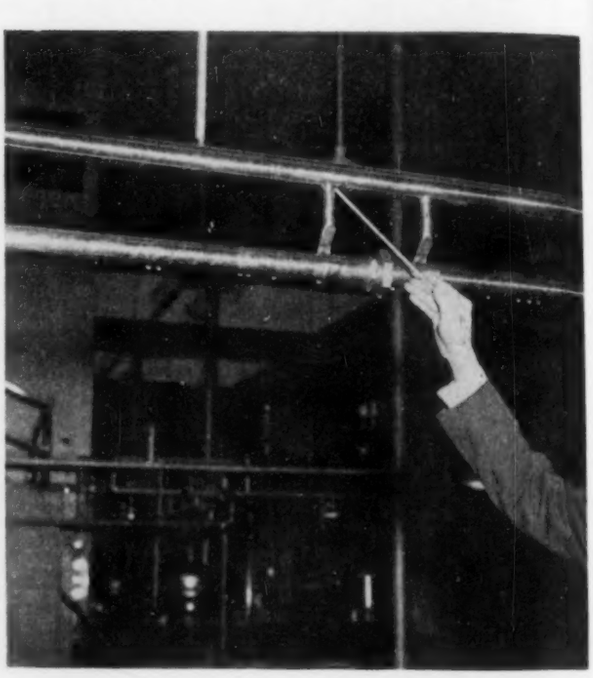


Fig. 5—These Arc-Welded Stainless Steel Pipes Are Being Used in a Chicago Dairy to Convey Milk

Current Welding Literature

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Stack-Cutting. Oxy-Acetylene Tips, vol. 21, no. 2 (Feb. 1942), pp. 36–37.

Metals, Straightening. Flame Straightening and Warp Control, C. W. Hale. Industry & Welding, vol. 15, no. 2 (Feb. 1942), pp. 24 and 26–27.

Metals, Volcano Effect. Nails from Ruins of St. Pierre, G. H. Enzian and H. F. Beeghly. Metal Progress, vol. 41, no. 2 (Feb. 1942), pp. 208–211.

Metal Working. Engineering Review of 1941 in Fabrication and Treatment of Processes. Metals & Alloys, vol. 15, no. 1 (Jan. 1942), pp. 52–62.

Non-Ferrous Alloys. Fusion Welding of Non-Ferrous Alloys, H. Martin. Metal Ind. (London), vol. 60, no. 10 (Mar. 6, 1942), pp. 172–173.

Oxyacetylene Cutting. Oxyacetylene Machine Cutting, A. H. Yoch. Steel, vol. 110, no. 7 (Feb. 16, 1942), pp. 93–94.

Oxyacetylene Cutting Machines. Aid to Portable Machine-Cutting. Oxy-Acetylene Tips, vol. 21, no. 3 (Mar. 1942), pp. 53–56.

Oxyacetylene Welding. Fluxes for Oxy-Acetylene Welding & Brazing, H. E. Landis, Jr., and F. C. Saacke. Metal Progress, vol. 41, no. 2 (Feb. 1942), p. 203.

Oxyacetylene Welding. Some Experienced Guidance on Costing Oxy-Acetylene Welding, C. G. Bainbridge. Sheet Metal Industries, vol. 16, no. 178 (Feb. 1942), pp. 219–21 and 223.

Oxyacetylene Welding. Steel. What Happens When You Weld Steel? Oxy-Acetylene Tips, vol. 21, no. 3 (Mar. 1942), pp. 60–61.

Petroleum Industry. Welding Grooves in Refinery Practice, W. L. Archer. Refiner, vol. 21, no. 2 (Feb. 1942), pp. 48–50 and 62.

Petroleum Refineries. Many Applications for Welding in Refinery Maintenance, G. W. Nigh. Nat. Petroleum News, vol. 34, no. 5 (Feb. 4, 1942), pp. R-34–36 and R-38.

Pipe Lines, Welding. Piping, G. F. Sherman. Heating & Vent., vol. 39, no. 3 (Mar. 1942), pp. 42–45.

Pressure Vessels. Welding Stainless Pressure Vessels, G. H. Sandberg. Amer. Machinist, vol. 86, no. 7 (Apr. 2, 1942), pp. 293–295.

Shipbuilding. All-Welded Ships Built by Ingalls, L. Grover. Naut. Gaz., vol. 132, no. 2 (Feb. 1942), pp. 14–18.

Shipbuilding. Progress in Shipbuilding, W. A. Woodeson. Electrician, vol. 127, nol 3308 (Oct. 24, 1941), p. 236.

Shipbuilding, Welding. Unusual Features of Fabrication and Hull Erection, R. Hughes. Shipbldg. & Shipg. Rec., vol. 59, no. 10 (Mar. 5, 1942), pp. 289–292.

Shipbuilding. Welding a Ship a Week, H. W. Young. Steel, vol. 110, no. 9 (Mar. 2, 1942), pp. 77–78 and 102.

Soldering. Paste Soldering. Steel, vol. 110, no. 9 (Mar. 2, 1942), pp. 82 and 111.

Soldering and Brazing, H. R. Brooker. Metal Ind. (London), vol. 60, no. 5 (Jan. 30, 1942), pp. 73–76.

Statistical Review. Weld. Engr., vol. 27, no. 3 (Mar. 1942), pp. 38–52.

Steel Testing. Tee-Bend Test to Compare Welding Quality of Steels, G. A. Ellinger, A. G. Biesell and M. L. Williams. U. S. Bur. Standards—J. Research, vol. 28, no. 1 (Jan. 1942) (RP 1444), pp. 1–49. Suppl. plates.

Structural Analysis Laboratory Research, 1940–1941, J. B. Wilbur. Mass. Inst. Technology—Pub. no. 80 (Dec. 1941), 59 pp.

Tools, Hand, Electric. Portable, Heat-Operated Tools Speed Product Fabrication. Elec. Mfg., vol. 29, no. 3 (Mar. 1942), pp. 68, 70, 72, 98 and 100.

Welded Steel Structures. Residual Stresses in Welded Structures, H. E. Rossell. Mar. Eng. & Shipg. Rev., vol. 47, no. 2 (Feb. 1942), pp. 101–102 and 106.

Weldability, H. Lawrence. Steel, vol. 110, no. 4 (Jan. 26, 1942), pp. 90 and 93–94.

Welds, Cracking. Crack Sensitivity of Welded Aircraft Steel, J. G. Ball. Metal Progress, vol. 41, no. 2 (Feb. 1942), pp. 213, 232 and 240.

Welds. Help Prevent Waste—Put Weld Metal Where It Belongs, A. S. Binck. Industry & Welding, vol. 15, no. 3 (Mar. 1942), pp. 50–56.

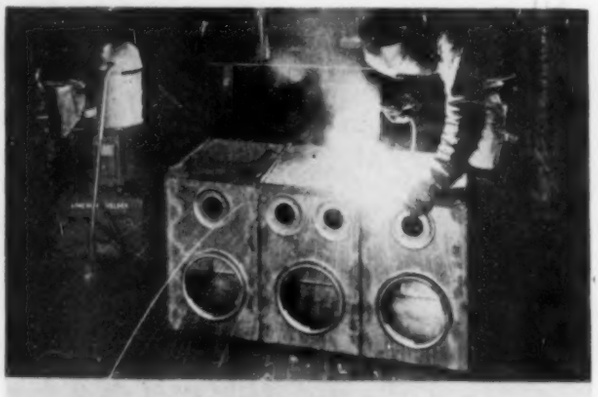
Manufacture of Mobile Lubricating Equipment Employs Arc Process of Welding

By A. F. Davis*

TODAY'S construction jobs are a race with time, particularly where war production is concerned. Only by careful maintenance of equipment with proper, periodic lubrication, can costly delays and disastrous breakdowns be avoided.

* Vice-President, The Lincoln Electric Co., Cleveland, Ohio.

Fig. 1—Arc Welding of Seams on "Convoy Luber" Gives Oil-Proof Joints and Maximum Strength



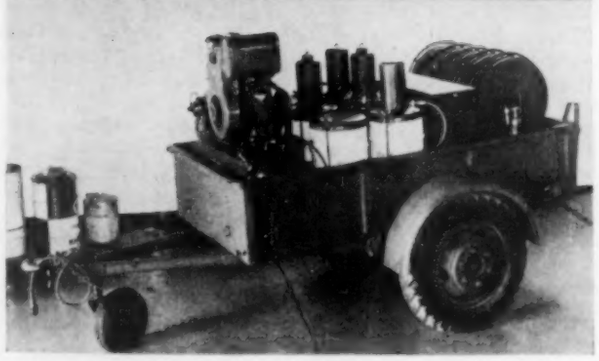


Fig. 2—Arc-Welded Grease Compartment Assembled with Other Units and Complete "Convoy Luber" Mounted on Trailer

Fig. 3—Army Field Test Showing How Arc-Welded "Convoy Lubers" Will Stand Up Under Rough Treatment

From Indo-China to the North Atlantic, from Alaska to the Caribbean, mobile lubritoriums, manufactured by the Gray Co., Inc., Minneapolis, are at work in all kinds of weather, aiding the war effort of the United Nations.

To speed production of this equipment so vital to the armed forces, the Gray Co. employs modern arc welding, using shielded arc equipment.

Figure 1 shows a welding operator at work on the seams of the grease compartment of a new "convoy luber." Employment of arc-welded construction assures top-speed production. Furthermore, welding assured the 100% oil-proof joints, and maximum structural strength, necessary on this job.

Figure 2 shows the arc-welded grease compartment assembled with other units of the mobile lubritorium. Units are mounted on either trailer, as pictured, or on truck, shown by Fig. 3, demonstrating how convoy lubers will stand rough treatment, traveling at high speeds over rough terrain. All welded parts must be strong to stand up under conditions such as these.

The decided advantages of this type of equipment to field operations of mobile army units are that it brings pressure lubrication to the job, offers complete facilities for all types of lubrication service, saves time and cost and lubricates efficiently.

When the convoy truck or trailer is needed for other uses, the lubricator itself is simply placed on the ground, or a suitable platform, where it continues full speed operation.

"Convoy lubers" are completely assembled and shipped in one crate. Units are quickly unpacked, and it is only a matter of minutes to load the lubricant tank and slide it onto a truck or trailer.

THE AMERICAN WELDING SOCIETY

ACTIVITIES — RELATED EVENTS

THE PRESIDENT'S MESSAGE

Opinions are frequently expressed in the daily and technical press as to the necessity of limiting the publication of information which, it is felt, would give assistance to the enemy. The extent to which engineering information should be disseminated depends upon a number of factors which may not always be considered in discussions of this question. In this article, reference is not made to military information concerning operations or materiel but rather to matters normally coming within the scope of activity of technical societies.

Our enemies are advanced in both science and engineering and there is every evidence to show that they have prepared technically for this war during the past decade and that their national economies have been organized for war. They used their engineering skill to make obsolescent the stores of munitions the allies retained or developed immediately after the First World War. The disclosures of the daily press indicate the extent to which the enemies obtain a knowledge of our activities.

This country's developments have been in the pursuit of peacetime activities and the establishment of better living standards. The organization of our war program has involved the development of new equipment and required the conversion of industry to the manufacture of products for which no previous experience was had. Not only were those units of industry which possessed strong technical staffs involved, but also the small manufacturers who had no technical personnel.

Industry is engaged in the production of articles for which there is a limited amount of information. The rate of organization of production depends largely upon the wisdom of technical decisions. An inexperienced organization working upon components delays the completion of the assembled product because of failure to understand how processing must be controlled to meet requirements.

The speed with which our production is organized and the speed with which we develop more powerful products depend upon the cooperative efforts of our research, design and production engineers. If these engineers and those dependent upon their decision are forced to work in closed compartments or without free access to the experience of others, we must expect delays and failures. Likewise, the efficiency of utilization of our inventors depends upon their knowledge of the existing level of development of our military products.

The processing methods of any one country depend largely upon the extent of the markets and the limitations of raw materials. There are always differences which cannot be leveled out, even though technical knowledge is freely published and equipment imported. In time of war these differences become greater because of the restrictions on movement of machinery, equipment and raw materials. Materials and methods of processing which are developed in this country cannot be applied in other countries without considerable effort and dislocations.

Had we spent the last decade in developing war products and had our enemies spent only a fraction of that time, then it is probable that the publication of information would be of aid to our enemies. However, under the conditions that exist, the need for technical knowledge in processing and in developing is so great that the advantage of open discussion and publication for the full utilization of engineering, inventive and design talent far outweighs any gain that might accrue to the Axis powers. Our strength lies in our productive capacity—not in the superiority of our brains.

The daily records of the war's progress have disclosed the magnitude of the technical preparations of the Axis. To overcome these there is needed all the cooperative effort of every engineer in the country. Our aim should be the assistance of those engineers through a rapid dissemination of technical information. Only through such unity of action may we hope to accomplish that which must be done.

WELDING RESEARCH FELLOWSHIP

A graduate fellowship in structural steel welding research available at Carnegie Institute of Technology offers an excellent opportunity to train for later positions in the welding industry. Applicants should hold a B.S. degree in Civil Engineering. The recipient of this fellowship will receive an annual stipend of $750, with opportunity of working for an M.S. degree, and freedom from tuition fees. He will be expected to devote one-half of his time, commencing September 1, 1942, to the Structural Welding Research program approved by the Structural Steel Welding Research Committee. Applicants should forward complete qualifications immediately to Professor F. M. McCullough, Head, Department of Civil Engineering, Carnegie Institute of Technology, Pittsburgh, Pa.

TENTATIVE SPECIFICATION FOR THE DESIGN, FABRICATION AND ERECTION OF STRUCTURAL STEEL FOR BUILDINGS BY ARC AND GAS WELDING

This Specification has been prepared by the Committee on Specifications, assisted by the Committee on Welding of the American Institute of Steel Construction, in order to provide a complete specification for the welding of steel for buildings.

This Specification has been made as comparable, and as similar as possible, to the A.I.S.C. Specification for Riveted Construction, which has been in wide use for many years and which covers the use of riveted, bolted or pinned connections.

The Institute has been represented by several of its members on the AMERICAN WELDING SOCIETY Committee on Building Codes, which prepared the A.W.S. Code for Arc and Gas Welding in Building Construction, 1941 Tentative Edition. Major portions of this Code have been adopted, by inclusion or by reference, in this tentative Specification.

There is, therefore, a present harmony between the tentative A.W.S. Code and this tentative A.I.S.C. Specification. It is expected that this harmony between the two documents will be maintained as they pass by revision from tentative status to full adoption. This Specification is intended to so augment the Code as to provide a complete document covering all phases of design, fabrication and erection of structural steel for buildings by arc or gas welding.

PROPOSED REVISION OF A.S.M.E. CODE FOR UNFIRED PRESSURE VESSELS

Section VIII—A.S.M.E. Boiler Construction Code

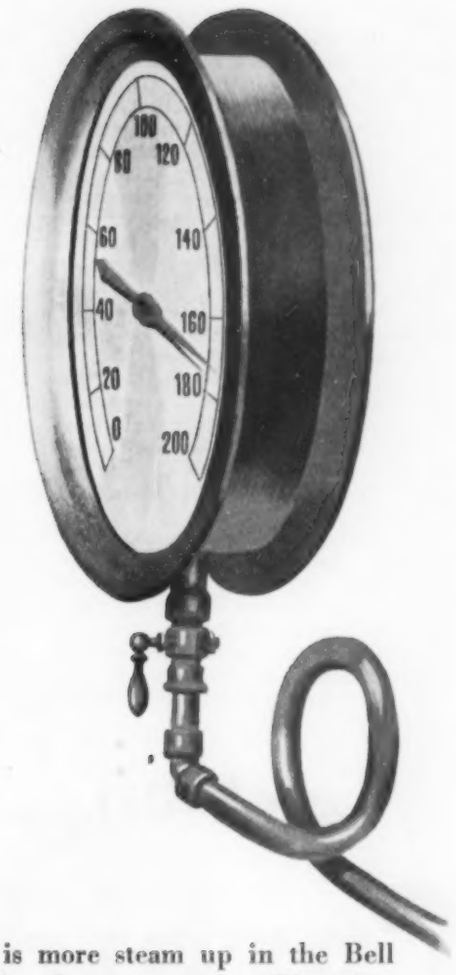
In the January 1938 issue of *Mechanical Engineering* (page 89) announcement was made of a modified plan for the revision of Section VIII of the A.S.M.E. Boiler Construction Code. This plan was outlined in considerable detail, and criticisms and suggestions were invited thereon.

The Special Committee of the Boiler Code Committee to Revise Section VIII has recently completed a preliminary draft of the proposed revision of Section VIII of the Code.

The general arrangement of the draft is quite similar to that followed by the A.P.I.-A.S.M.E. Code for Unfired Pressure Vessels. The important changes between the present Section VIII and the proposed revision can be briefly summarized as follows:

1. The uses to which vessels built

"Carrying lots of pressure these days..."



"THERE is more steam up in the Bell System than I ever remember. The wires hum with war and wartime production. There's more telephoning than ever before.

"The pressure of war and war's work is on—especially on our toll lines. If you are going to use Long Distance you can help by —

Knowing the number you want to call.

Calling in the less busy hours — before 10 A. M. and after 8 P. M., for example.

"Let's give vital war calls the right of way and make equipment go as far as possible, saving copper and other materials for the war."

BELL TELEPHONE SYSTEM

"The Telephone Hour"— *presenting great artists every Monday evening — N. B. C. Red Network*

under a given set of requirements can be put on account of the difference in the hazard involved, which are now specified in Pars. U-68, U-69 and U-70, have been eliminated except for vessels containing lethal liquids and gases which are required to be both stress relieved and radiographed.

2. The efficiencies of fusion-welded joints are the same as given in the A.P.I.-A.S.M.E. Code.

3. The rules for determining the shell thicknesses of vessels include an additive thickness for corrosion designated by c in the formulas. The added thickness c may be zero when previous experience has shown that corrosion does not occur. For air, steam and water vessels, c is to be made equal to $t/6$, except it need not exceed $^1/_{16}$ in.

4. Provision is made for a minimum factor of safety of four for vessels constructed of steel plate.

5. Appendix *A* will contain recommendations which will not be mandatory for periodic inspection, repair and maintenance, and allowable safety valve settings for vessels in service. They are adapted particularly to the oil-refining industry.

6. Mandatory rules have been included for trepanning specimens from the main welded joints, where such vessels are not radiographed and have plate thickness in excess of $^1/_4$ in. However, local radiographic examination of the welded seam may be substituted.

7. Premiums are allowed for the work performed on the vessel, the greatest premium being for a vessel which is radiographed. Where mandatory stress relieving and/or radiographing is not required either or both of these operations may be performed and the premiums used accordingly.

8. The hydrostatic and proof tests follow closely the requirements of the A.P.I.-A.S.M.E. Code.

Although the draft has been submitted to the members of the Boiler Code Committee, it has not been discussed by them and is therefore subject to possible change. However, the Committee has decided to release this preliminary draft for general distribution and critical review, in order to expedite the work as much as possible. Comments are invited from all interested parties, with the request that they be received by the Secretary of the Boiler Code Committee not later than July 1, 1942.

Copies of this draft may be obtained from the A.S.M.E., 29 West 39th St., New York, N. Y., at $1.00 per copy.

The personnel of the Special Committee is as follows: E. R. Fish, *Chairman*, Hartford, Conn.; R. E. Cecil, Oakmont, Pa.; A. J. Ely, Elizabeth, N. J.; D. S. Jacobus, Montclair, N. J.; K. V. King, San Francisco, Calif.; C. O. Myers, Columbus, Ohio; D. B. Rossheim, New York, N. Y.; Walter Samans, Philadelphia, Pa.; H. S. Smith, New York, N. Y.; Walter Steggall, Technical Editor, Jersey City, N. J.

AMERICAN STANDARD DEFINITIONS OF ELECTRICAL TERMS, C42

A new American Standard known as Definitions of Electrical Terms, C42, sponsored by the American Institute of Electrical Engineers, is now ready for general distribution. The issue of this volume of electrical definitions as an American Standard should mark an epoch in the literature of the electrical art in America, as it is the first time the definitions of the important terms common to all branches of the art as well as those specifically related to each of the various branches have been assembled and printed under one cover.

This glossary is the result of more than twelve years' work of a sectional committee of 46 members having 18 subcommittees drawn from available specialists. More than 300 individuals have given material assistance and many others have assisted in specific instances. The 34 organizations represented on this sectional committee include the national engineering, scientific and professional societies, trade associations, government departments and miscellaneous groups.

The "Definitions" book is a handsome sturdy volume of some 300 pages, 8 x 11 in.; high quality paper and printing; dark blue fabricoid binding, gold lettering, thoroughly indexed. Price is $1.00 net each in U. S. A. to all on single copies or in quantity; $1.25 outside U. S. A. Make checks or money orders payable to AIEE. Address AIEE Headquarters, 33 West 39th St., New York, N. Y.

National

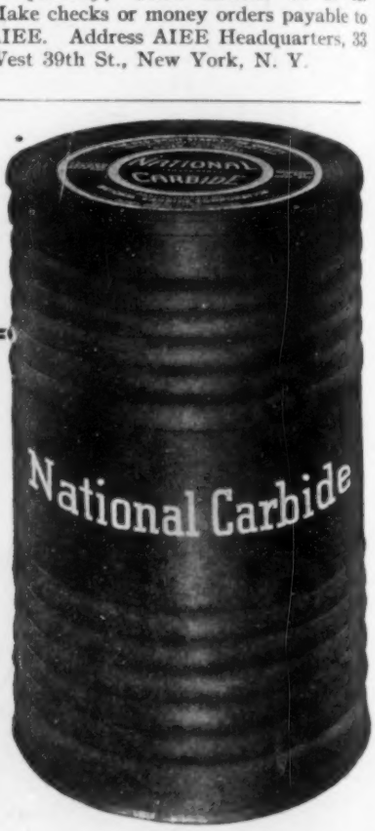
Carbide

IN THE RED DRUM

EFFICIENT

ECONOMICAL

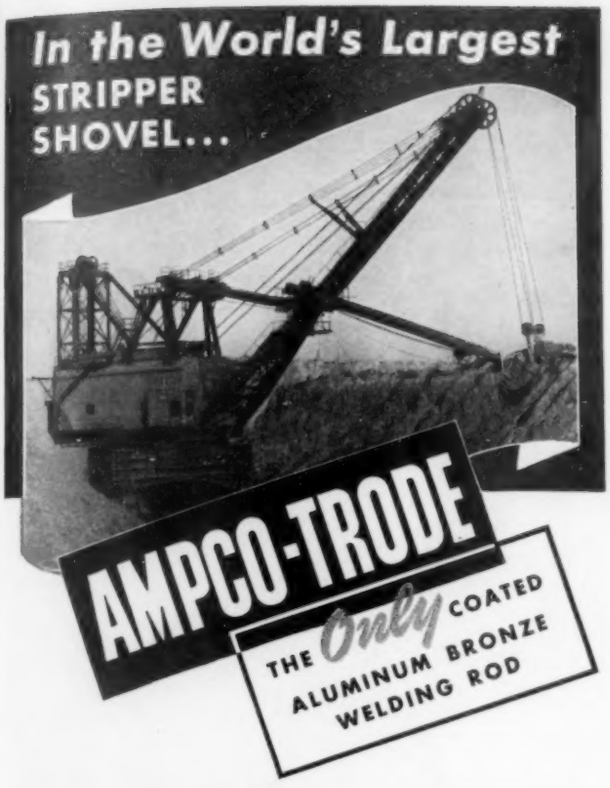
DEPENDABLE



FOR WELDING and CUTTING

Use National Carbide in the Red Drum

60 E. 42nd St. NATIONAL CARBIDE CORPORATION New York, N. Y.



The four huge leveling pistons in the Bucyrus-Erie 1050 stripping shovel—the largest yet produced—have, in the machine illustrated, an overlay of Ampco-Trode coated aluminum bronze welding rod.

Since the pistons work automatically—keeping the 2,800,000 pound machine level at all times—the bearing qualities of the weld overlay are of great importance.

The bronze weldrod is made of Ampco Metal, outstanding as an alloy with excellent bearing characteristics that can take hard punishment and like it. These qualities are inherent in Ampco-Trode electrodes.

Grade 18 Ampco-Trode rod was best adapted for the Bucyrus-Erie application. This is one of the seven grades of Ampco-Trode weldrod. The series have a range of tensile strength of 50–80,000 p.s.i. Hardness is 100 to 375 Brinell. Rods are made in six sizes—$\frac{1}{8}$" to $\frac{1}{2}$" diameter. Suitable for welding by metallic arc, carbon arc or oxy-acetylene methods.

FREE BULLETIN

Ask for latest Ampco-Trode Bulletin describing these bronze welding rods and giving welding technique and instruction. Sent free on request.

AMPCO METAL, INC.

Dept. WJ-5 Milwaukee, Wis.

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OSTROM JOINS W.P.B.

After April 20th, Mr. K. W. Ostrom will be associated with the War Production Board. His position will be to head up a welding unit in the General Industry Equipment Division of the W.P.B. Mr. Ostrom's former connection was with Arcos Corporation as Welding Technician and Field Engineer.

JOHN S. RICHARDS PROMOTED

John S. Richards has been appointed director of research of the American Steel & Wire Co. and will be succeeded as manager of the metallurgical department by James R. Thompson.

Mr. Richards was born in McKeesport, Pa., attending the public schools of that city before matriculating at the Carnegie Institute of Technology, where he majored in chemistry, engineering and metallography. His first association with United States Steel was as a chemist at the National Tube Co., beginning in November 1912. In September of the following year he was promoted to the post of assistant chief chemist at the Edgar Thomson Works of Carnegie Steel Co. He continued in that position until September 1928, when he was transferred to American Steel & Wire Co. as head chemist at Donora (Pa.) Steel Works. In June 1930 Mr. Richards was named assistant superintendent of the open hearth division at the same plant. In October 1934 he was transferred to Cleveland as a metallurgist and in December of the following year was named director of manufacturing practices. In April 1937 he was appointed manager of the metallurgical department, which post he has held to the present time.

NEW BOOKLET ON FABRICATION AND REPAIR OF FARM EQUIPMENT

The many opportunities for agricultural repair work that are afforded to welding shops by the nation-wide farm machinery repair program are described in a new 12-page, illustrated booklet, *The Fabrication and Repair of Farm Equipment*, which has just been published by The Linde Air Products Company, a unit of Union Carbide and Carbon Corporation. The booklet lists a variety of ways in which the oxyacetylene welding and cutting blowpipe is being used in farm maintenance work for bronze welding and bronze surfacing, hard facing, fusion welding, heating, hand cutting and flame hardening. Advertising suggestions for soliciting repair work are also given in a section of the booklet devoted to hints for selling the service to farmers.

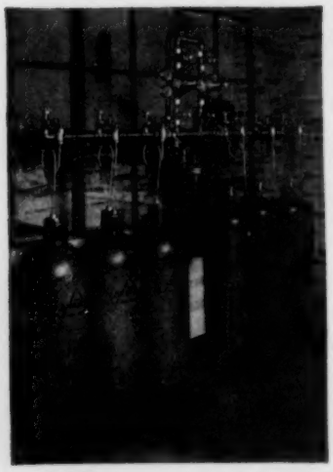
Copies of this booklet can be obtained without cost by writing to the nearest office of The Linde Air Products Company or to the Company's general offices, 30 East 42nd St., New York, N. Y., and asking for Form 5106.

WESTENDARP HONORED

H. O. Westendarp, General Electric welding engineer and member of the AMERICAN WELDING SOCIETY, was among thirty-seven General Electric employees recently awarded Charles A. Coffin Foundation Awards for outstanding contributions made during 1941 toward the progress of the Company and the electrical arts. These awards consist of an engraved certificate and a cash honorarium.

Mr. Westendarp's citation read, in part, "In recognition of his unique commercial and engineering contributions in the arc welding industry."

For SAFETY SPEED ECONOMY



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REGULATORS
VALVES and
FITTINGS
to control high pressure gases

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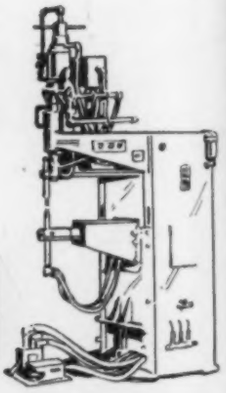
Pioneers and Manufacturers of Precision Equipment for Using and Controlling High Pressure Gases

WELDING HITS A NEW HIGH



NEW Oakite Cleaning Process for Aluminum Helps You Get MORE Welds in Less Time!

If you are spot welding aluminum alloy structures or assemblies, you can easily SPEED-UP PRODUCTION by using a newly developed and APPROVED Oakite process that successfully and SAFELY prepares metal surfaces for this operation. Let specially designed Oakite cleaning materials help you in preparing metal parts of all types for any welding operation. Interesting data mailed FREE to production and engineering executives, supervisors and foremen requesting it on their business letterhead.

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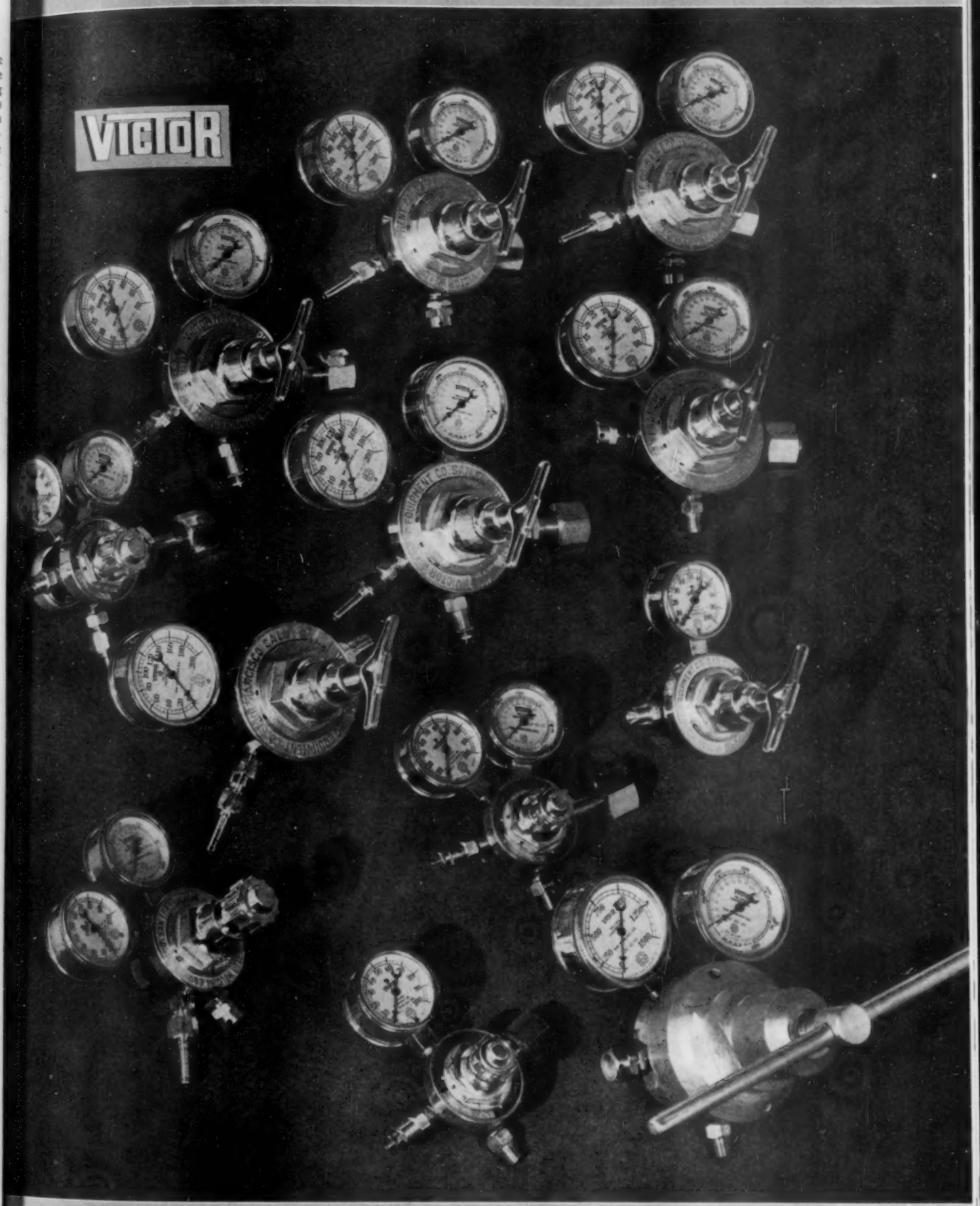
Representatives in All Principal Cities of the United States and Canada

OAKITE Specialized CLEANING

Fine Regulators Reduce Your Cost



VICTOR EQUIPMENT COMPANY • SAN FRANCISCO

844-54 FOLSOM STREET

ALUMINUM BRONZE WELDING RODS

A new catalog, just issued by Ampco Metal, Inc., Milwaukee, Wis., describes in detail the welding technique and application of Ampco-Trode coated aluminum bronze welding rod, suitable for metallic arc, carbon arc and oxyacetylene welding.

Among the applications covered in the new book are welding on Ampco Metal, brass and bronze, steel, cast iron, alloy steels and nickel alloys, by various methods. General welding instructions are given, so that the welding engineer has a comprehensive knowledge of the technique of welding with aluminum bronze rods.

Copies will be sent free to welding engineers interested in learning more about aluminum bronze rods.

CAPACITOR WELD UNITS

A four-page technical bulletin, No. 1300, describing the new "Revers-O-Charge" capacitor weld units has been released by Weltronic Corporation of . . . . E. Outer Drive, Detroit. The bulletin explains the operation of several new features of the "Revers-O-Charge" and presents a schematic diagram of the new condenser discharge circuit. The "Revers-O-Charge" design eliminates all moving elements between condensers and welding transformer, automatically reverses the charge polarity after each weld and does away with several relays in the power circuit. A price list of the various models available is included in this folder. Copies are available directly from Weltronic Corporation.

SEQUENCE AND WELD TIMERS

Sequence and weld timers—automatic control for resistance welders—are described in a new seven-page leaflet announced by the Westinghouse Electric and Manufacturing Company.

Definitions and general information about sequence and weld timing, pulsation and spot welding are given. Timers are completely described and illustrated. Operating details cover charging rate, "repeat" and "non repeat" operation and pulsation timing. Circular charts are used to show the timing sequence of squeeze, weld and hold time in terms of number of cycles for both pulsation and spot welding.

A copy of descriptive data 18-343 may be secured from department 7-N-20, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

WELDED YACHT

Have you ever wanted a yacht? Here are basic plans for a trim 27-ft. all-welded yacht that you can build "after victory" for less than $800 (including motor).

Courtesy Hobart Brothers Co.

William Billark, welder, of Kitchener, Ontario, built this craft in his spare time during two summer months.

Rudder, running lights, hand rails, anchor, port lights, deck cleats and engine controls were made from scraps of material used on the yacht. Here is a complete list of the major materials used:

144 sq. ft. 10-gage plate for bottom and up to waterline.
300 sq. ft. 14-gage plate for hull and decks.
24 sq. ft. 18-gage sheet steel for wheel house.
36 sq. ft. 4-in. light channel iron for keelsons.
370 ft. of $2^1/_2$ x $^5/_8$ x $^1/_8$-in. flat iron deck stringers.
600 ft. $1^1/_4$ x $^3/_{16}$-in. flat iron deck stringers and transom reinforcements.
56 ft. $1^1/_2$-in. black pipe split in half for coaming and guard rail.
24 ft. x 17 in. x $^1/_4$-in. plate cut across for keel corners.
24 ft. x $2^1/_2$ x $^3/_8$-in. flat iron for keel.

MALLORY STANDARDIZED WELDING ELECTRODES

SPEEDIER PRODUCTION
LESS DOWN TIME
BETTER WELDING
LOWER COST

Spot welding speeds plane production. Seam welding speeds shell production. Flash and butt welding speed tank and jeep production. Mallory tips and holders, wheels and dies speed resistance welding all along the production front. Write today for your free copy of the factual Mallory Resistance Welding Data Book.

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Buy "Proven Fluxes" with Years of Guaranteed Satisfaction behind them
The Trade-Name is "ANTI-BORAX"

Ask for Them *Unequalled for Quality*

A Flux for every metal: Cast Iron Welding Flux No. 1; Brazing Flux No. 2; Braz-Cast Flux No. 4, for bronze-welding cast iron; "ABC" Aluminum Flux No. 8 for sheet Aluminum and all alloys of Aluminum; Stainless Steel Flux No. 9; Silver Solder Brazing Flux No. 10; "Anti-Borax" Tinning Compound No. 11.

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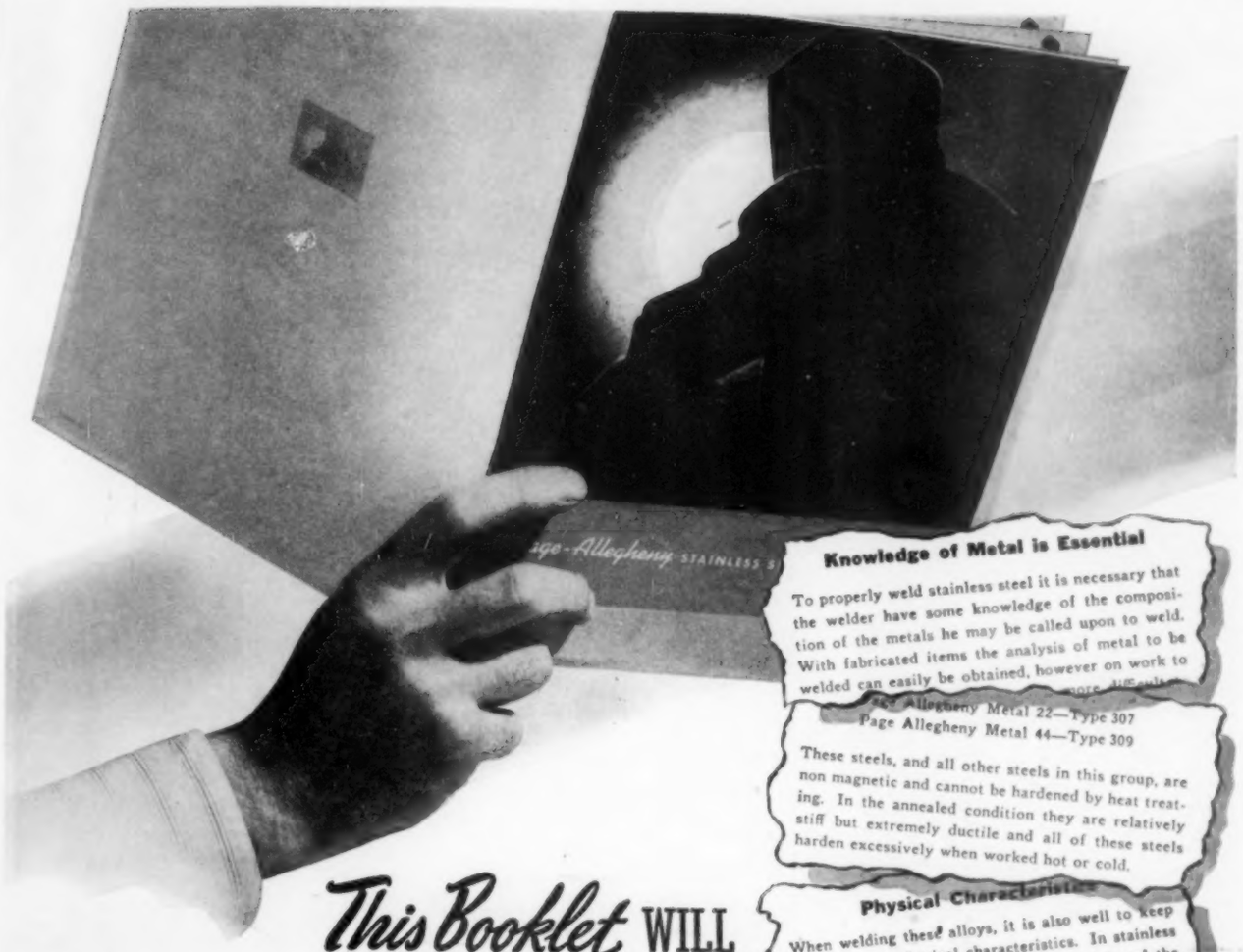
You'll do it better with
SHAWINIGAN CARBIDE

SHAWINIGAN PRODUCTS CORPORATION
EMPIRE STATE BLDG., NEW YORK



Knowledge of Metal is Essential

To properly weld stainless steel it is necessary that the welder have some knowledge of the composition of the metals he may be called upon to weld. With fabricated items the analysis of metal to be welded can easily be obtained, however on work to

Page Allegheny Metal 22—Type 307
Page Allegheny Metal 44—Type 309

These steels, and all other steels in this group, are non magnetic and cannot be hardened by heat treating. In the annealed condition they are relatively stiff but extremely ductile and all of these steels harden excessively when worked hot or cold.

Physical Characteristics

When welding these alloys, it is also well to keep in mind their physical characteristics. In stainless steels, the coefficient of expansion is high and the heat conductivity is low, therefore, when setting up a job for welding these factors must be taken into account and allowance made for expansion and con-

STANDARD GRADES

The following list shows standard grades of stainless steels. Those which are not included in the standard classif on special order.

GRADE	TYPE NO.	CARBON	CHROME
Allegheny 17/7	301X	.10-.20	16.00-18.00
Allegheny "C"	302	Over .08-.20	17.00-19.00
Allegheny Metal F.M.*	302B	Over .08-.20	17.00-19.00
	303	.20 max.	17.00-19.00
Allegheny "A"	304	.11 max.	17.00-19.00
Allegheny "B"	305	Over .05-.20	16.00-20.00
Allegheny "B" Spec.	306	.11 max.	16.00-20.00
Allegheny 22	310	Over .08-.20	19.00-22.00

PAGE-ALLEGHENY STAINLESS STEEL ELECTRODES

CHROMIUM 18.
NICKEL 8.
CARBON .07 Max.
with COLUMBIUM
SIZE HEAT
POUNDS SET

PAGE-ALLEGHENY 18-8 ELECTRODES WITH COLUMBIUM

Base metal and coating balanced to form weld metal of the following chemical composition:
Carbon .07% Maximum; Chromium 18% Minimum; Nickel 9% Minimum with Columbium.

Recommended for welding all grades of Stainless Steel in which the chrome and nickel

PAGE-ALLEGHENY STAINLESS STEEL ELECTRODES

CHROMIUM 18.
NICKEL 9.
CARBON .07 Max.
SIZE HEAT
POUNDS SET

PAGE-ALLEGHENY 18-8 ELECTRODES

Base metal and coating balanced to form weld metal of the following chemical composition:
Carbon .07% Maximum; Chromium 19% Minimum; Nickel 9% Minimum.

Recommended for welding all grades of stainless steel in which the Chrome and Nickel content is not in excess of 19% and 9% respec-

This Booklet WILL HELP YOU SAVE TIME AND MATERIAL

..AND GET BETTER STAINLESS STEEL WELDS

WITH Stainless Steel on the critical list, it has become vital to take every possible means to conserve it.

It is worthwhile, for example, to instruct your men not to bend the electrodes and to use every one right down to the holder. Waste no part of them that can be used.

Then get the kind of information contained in this booklet by PAGE. It lists 42 grades of Stainless Steel with their type number and analyses. It lists the electrodes to use with these. And it gives such needed data as the physical characteristics of certain well-defined groups of "Stainless"—their reaction to heat and to cold working, etc. It gives such definite instructions as correct amperage and voltage; polarity, length of arc; direction of arc; starting the weld; preventing undercutting, etc.

Ask your local PAGE Distributor for a copy of this booklet.

PAGE WELDING ELECTRODES

PAGE STEEL AND WIRE DIVISION • MONESSEN, PA., ATLANTA, CHICAGO, NEW YORK, PITTSBURGH, SAN FRANCISCO

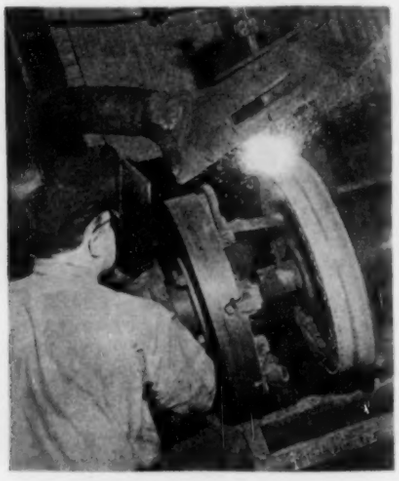
ACCO

AMERICAN CHAIN & CABLE COMPANY, Inc.
BRIDGEPORT • CONNECTICUT

110 x 3½ x ⅜-in. flat iron for stern (forged).
23 ft. x ½-in. pipe for hand railings.
Brooks Steamer Engine being used at present time due to gas shortage.

RETREADS APLENTY, BUT NOT FOR AUTOS

In industrial centers around the nation's coal fields thousands of retreads are being made, not for automobiles but for mine locomotives that every day haul millions of tons of coal from deep in the mine pits. The coal is delivered to the furnaces of steel mills, munitions plants and other industries producing war materials.



Making Retreads for Locomotives

Once good only for scrap steel, worn mine locomotive tires now are being retreaded several times. Each retread mileage approximates that of an original tire. Westinghouse is now retreading steel tires at the rate of 6000 a year in shops at Pittsburgh, Wilkes-Barre and Johnstown, Pa., and St. Louis, Mo. A fifth retreading unit soon will be installed in the Westinghouse service shop at Fairmont, W. Va.

The mine locomotive wheel shown herewith is being retreaded on an automatic electric welding machine at the Westinghouse Homewood plant in Pittsburgh. By filling inch-deep grooves in the worn metal tires with high carbon steel, a mine locomotive tire is given additional mileage nearly duplicating the original tire. Fifty pounds of weld often recondition a 200-lb. steel tire that otherwise would be scrapped. Engineers estimate that Westinghouse conserves about one million pounds of steel annually by this retreading. Development of automatic electric welding is responsible for this saving.

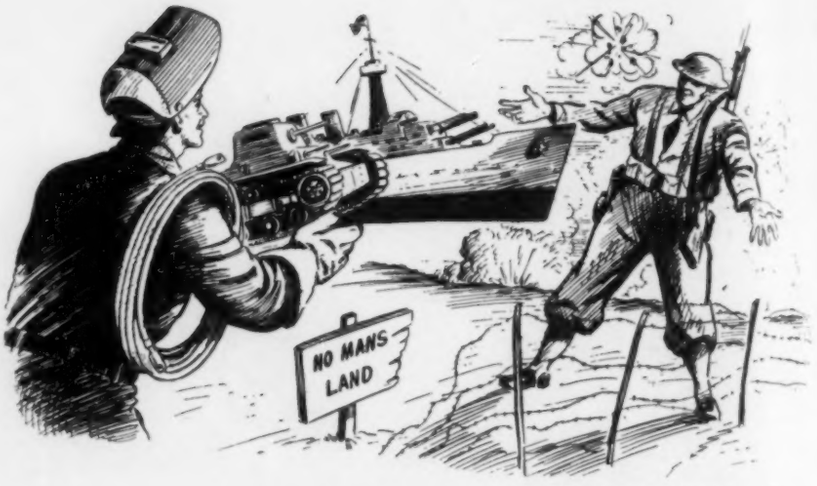


Photo courtesy Hobart Bros. Co.

A Welded Cooperation

COMMUNICATION TO THE EDITOR

American Welding Society,
New York City,
New York

Dear Sirs:

Arc welding has been instrumental in reclaiming much equipment in Alaska that formerly was junked, and has saved valuable time in breakdowns, for we usually can repair parts without dismantling, which, when it involves parts weighing many tons, would take days to remove and replace.

I would like to see the Society advocate a standard form for reports of welding procedure for repairs; as, for example:

1. Description of object that failed: its construction, materials, etc.
2. Cause of a failure or break.
3. Nature of break or failure.
4. Method of setting up or alignment for repair and reinforcement used, if any. Reinforcement decided from No. 2, whether failure was due to weakness in design or accidental failure.

Welding technique used:

1. Preheat, if any. Time and temperature given.
2. Electrodes: material, size and welding current values given.
3. Welding sequence and positions given.
4. Other methods than welding, used to control warping or distortion.
5. Annealing—time and temperature given.
6. Rate and method of cooling weld—natural or controlled, where welded part is not annealed.
7. Remarks: Repairs that fail again, and how they were overcome, and other pertinent facts.

If all reports followed a standardized form like the above, supplied with photographs or sketches, and were used in the JOURNAL and other trade publications, it would be possible to build up a loose-leaf welding repair handbook Such a book would enable one to proceed with confidence on similar repair jobs and save valuable time and material. I am sure members of the SOCIETY, operators and others who are interested in this type of welding, could be encouraged to send in their reports in this manner. In this way, repair welding would cease to be an experiment each time, and develop into more of a science.

Yours truly,
B. L. CROSBY

SOUTH AMERICAN PHOTOS SHOW USES OF WELDING

The accompanying illustrations showing various uses of arc welding were supplied to The Lincoln Electric Company, Cleveland, Ohio, by Armco International Corporation, who obtained them from their distributors in South America.

LEARN ABOUT THE NEW PROCESS OF LOW TEMPERATURE WELDING
Standardized by leading manufacturers for:
Salvaging of Defective Castings in cast iron, malleable steel, bronze, brass, nickel, aluminum, etc. Faster Production of fabricated parts in steel, stainless, chrome-moly, non-ferrous, aluminum, and for salvaging tools.
FREE LITERATURE
Write on your firm letterhead for new 32-page book on Low Temperature Welding.
with CASTOLIN EUTECTIC WELDING ALLOYS
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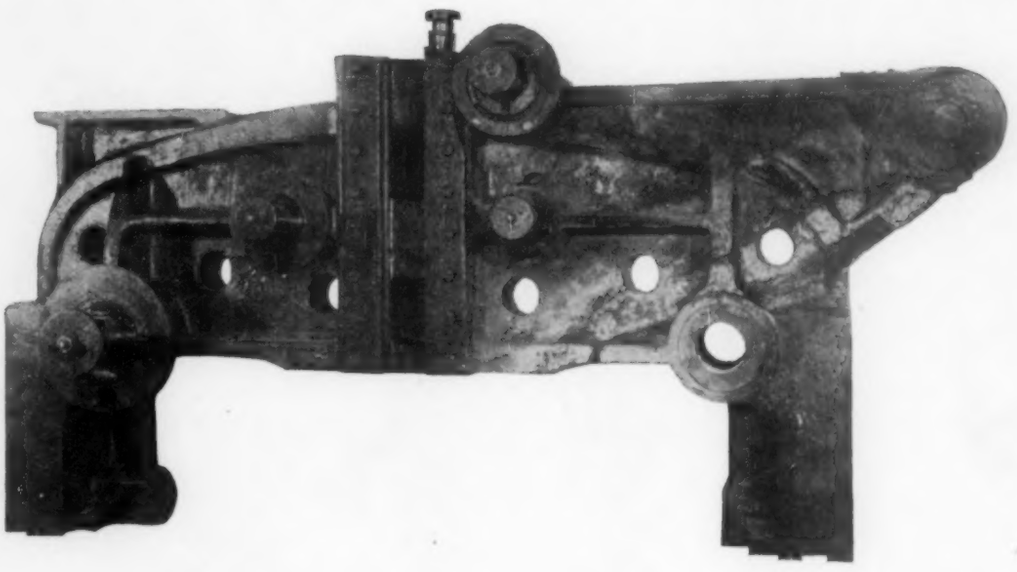


BACK IN ACTION...TRIPLE ACTION...

because of speedy, reliable Tobin Bronze Welding

INCALCULABLE sums are saved for industry every year in both equipment and time by repair welding with Tobin Bronze—the original low melting-point (1625°F) bronze welding rod.

Take, for example, this badly fractured 15-ton triple action press crown that was disabled when a break occurred in the two webs above the right hand cross shaft bearing. This production giant was needed vitally...and it was back on the job in a week—thanks to the Super Arc Welding Company of Detroit and 1150 lbs. of Tobin Bronze.

A feature of this repair was the fact that the completed weld required no machining. After tack welding, bearings were checked for alignment...and constant checking was maintained during the entire welding operation.

For information on welding with Tobin Bronze* and other Anaconda Rods, ask us to send our Publication B-13. You'll find its data doubly useful at this time when speed is the watchword.

6394

*Tobin Bronze is a trade-mark of The American Brass Company registered in the U. S. Patent Office.

ANACONDA *Anaconda Welding Rods*

THE AMERICAN BRASS COMPANY—GENERAL OFFICES: WATERBURY, CONNECTICUT

In Canada: ANACONDA AMERICAN BRASS LTD., New Toronto, Ontario • *Subsidiary of Anaconda Copper Mining Company*

Fig. 1

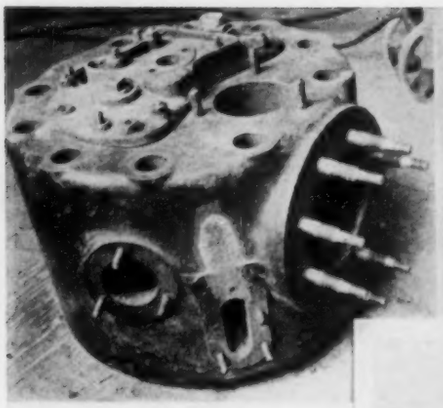


Fig. 2

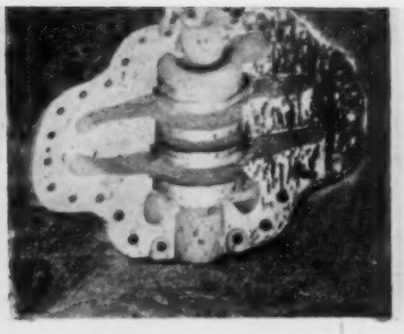
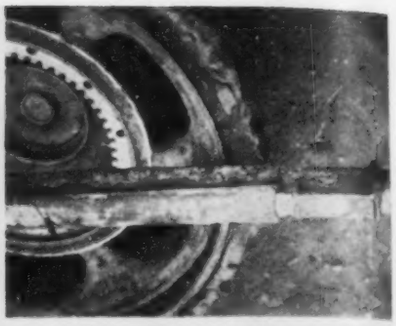


Fig. 3



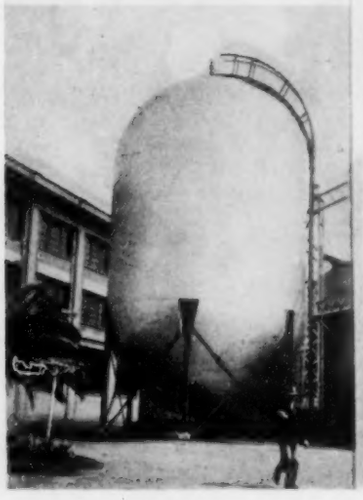
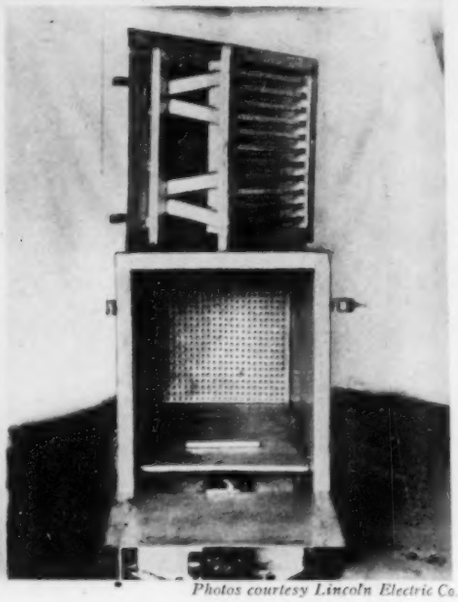


Fig. 4

Fig. 5



Photos courtesy Lincoln Electric Co.

Fig. 6

Figure 1—Cast-iron Diesel engine cylinder head repaired by Ernesto Trivellato for A. Campos & Cia. at Tatui, São Paulo, Brazil, with special electrodes manufactured expressly for cast iron. Welded repair cost less than replacement.

Figure 2—Cast-iron casing for centrifugal pump repaired for Central Juncos at Juncos, Puerto Rico. One hundred and fifty pounds of electrodes were used in building up the worn parts.

Figure 3—Forged steel front axle for truck repaired at San Juan, Puerto Rico. Of the many axles repaired in this way, not a single one has ever failed in service.

Figure 4—Compressed gas container fabricated of mild steel for the São Paulo Gas Company, Ltd., under supervision of the welding division of Armco International Corporation. The container is 15 meters high and 6 meters in diameter.

Figure 5—Stainless steel pressure vessel fabricated of 18–8 metal and cast iron by S. A. Industrias Reunidas Francisco Matarazzo for A. Campos & Cia. in São Paulo. This vessel has a capacity of 200 meters, and has a steam-heated double bottom with a working pressure of 30 lb.

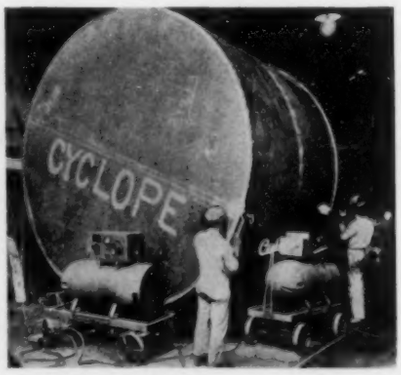


Fig. 7

Fig. 8

Figure 6—Stainless steel wool dryer fabricated of 18–8 metal by Jose Cortelazzo for S. A. Moinho Santista in São Paulo. Welding was used because of its low fabrication cost. Low cost of fabrication was the reason for using welding.

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UNITED STATES STEEL

Figure 7—Fermentation tank fabricated by Cyclope at São Paulo for Cia. Cervejaria Brahma. This tank has an inside diameter of 3700 mm. and the total height is 2800 mm. It is fabricated of mild steel plate 6 mm. and 8 mm. thick.

Figure 8—Special fence fabricated of $^3/_8$-in. reinforcing rods by Miguel Angel Rodriguez for Central Juncos, Juncos, Puerto Rico.

BALDWIN LOCOMOTIVE TRAINS WELDING OPERATORS

The Baldwin Locomotive Company is speeding production of 28-ton combat tanks by training arc-welding operators for their shops. Each welding trainee at Baldwin is given individual instruction and soon learns—and earns—his way to a position of responsibility.

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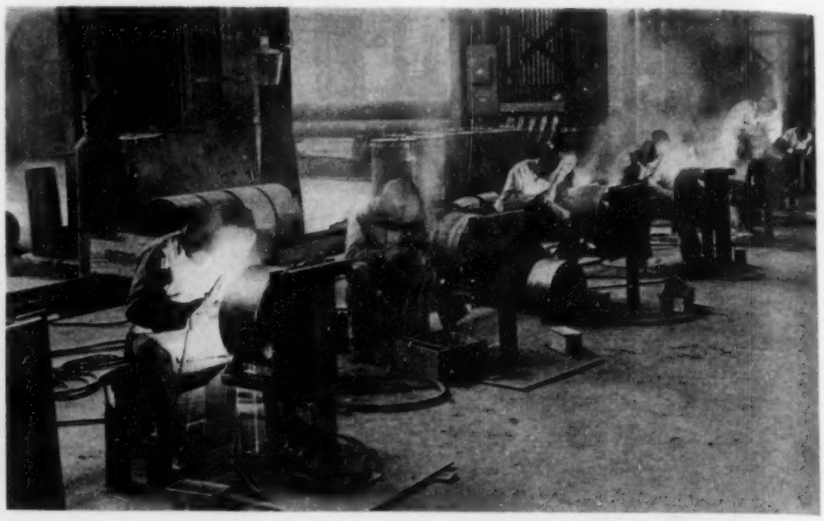
As an aid to these trainees, sample welds are mounted on panels to enable them to compare their own welds with typical welds as approved for different types and sizes of joints in various positions. The sample welds are so arranged that they can be inspected from every angle, and are welded to the panels to prevent their being jarred loose.

With the accent on production at Baldwin, every effort has been made to speed the deposit of weld metal. For example, operators engaged in welding "bogie wheels" for tanks are provided with fixtures for holding the work so that each joint can be revolved into position for easiest welding, allowing the use of the largest practical size of electrode.

They are also provided with a.c. arc welders, which permit the use of maximum welding current without troublesome magnetic arc blow. These arc welders are of the transformer type with built-in power-factor correction, and are used for the majority of the work in this plant.



Photos courtesy General Electric Co.

"Bogie-Wheels" for M-3, 28-Ton Combat Tanks; Being Fabricated with Arc Welding by Means of Home-Made Positioning Equipment Made of Pipe, Etc.

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Harris, Edward (D), 128 Calumet St., Roxbury, Mass.
Howard, Edwin J. (C), 195 North Shore Rd., Revere, Mass.
Smith, Clinton C. (C), 192 Raleigh Way, Portsmouth, N. H.

CANADA

Bisset, R. E. (C), 7 George St., St. Catherines, Ont., Canada.
Clingersmith, Orval E. (D), 21 Lowe St., Chatham, Ont., Canada.
Cohen, Sydney (D), International Machinery Co., 73 Robert St., Hamilton, Ont., Canada.
Coulter, Warren R. (C), Coulter Copper & Brass Co., 115 Sumach St., Toronto, Ont., Canada.
Heal, E. (C), The Steel Co. of Canada, 334 Wellington St., N., Hamilton, Ont., Canada.
Weaver, J. M. (D), 48 Locke St., S., Hamilton, Ont., Canada.

CANAL ZONE

Franklin, Raymond J. (C), Box 214, Diablo Heights, Canal Zone.
Hancock, James H. (C), Box 1146, Diablo Heights, Canal Zone.
Johnson, Victor J. (C), Box 275, Diablo Heights, Canal Zone.
Liebig, John O., jr. (C), Box 420, Diablo Heights, Canal Zone.
Trott, Fred R. (D), Box 1082, Balboa, Canal Zone.

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Becker, Walter C. (C), Ohio Brass Co., Mansfield, Ohio.
Fenn, W. T. (C), 648 Viewpoint Ave., Cuyahoga Falls, Ohio.
Meyer, Edwin H. (D), 829 Leonard St., Akron, Ohio.
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Owens, Roy (B), Electro-Motive Div., La Grange, Ill.
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Reilly, William L. (C), 1215 N. Elmwood Ave., Oak Park, Ill.
Rhode, Maynard (D), National Lock Co., 1902—7th St., Rockford, Ill.
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Pilarsky, Joseph A. (D), 4117 Gifford Ave., Cleveland, Ohio.
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Roller, George (B), Guarantee Iron Wks., 16 Railroad St., Rochester, N. Y.
Salitter, Harmann (D), 28 Fairlea Dr., Rochester, N. Y.

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Chilton, Howard E. (C), 332 Arlington St., Watertown, N. Y.
Clouse, Ben T. (D), 431 E. Wayne St., Ft. Wayne, Ind.
Geisland, J. C. (C), City Auto Stamping Co., Lint & Dura Aves., Toledo, Ohio.
Kelly, R. M. (D), 1133 So. Brighton St., Dallas, Texas.
Moss, Ashley R. (B), 100 Haverstock Hill, Hampstead, London, N. W., 3, England.
Naylor, C. E. (C), Industrial Training Inst., 1358 Grandville Ave., S. W., Grand Rapids, Mich.
Negron, Daniel R. (C), Humacao Industrial School, Comercio 53, Ponce, Puerto Rico.
Pyle, Lawrence G. (D), Box 644, Bounder City, Nevada.
Snell, Sam W. (B), 5539—304th, Toledo, Ohio.
Stefanson, Skuli (D), Box 171, Park River, No. Dakota.
Stephenson, R. C. (D), 334 Oldham Ave., Lexington, Ky.
Stolte, Emil (C), 204 Roosevelt Ave., Springfield, Mass.
Thure, Donald (C), 849 Burton St., S. E., Grand Rapids, Mich.
Williams, Robert (C), Gardner Denver Co., Quincy, Ill.

NEW SUSTAINING MEMBER

National Electric Welding Machines Co.
Bay City, Michigan

National Electric Welding Machines Co. is welcomed as a new sustaining member in the AMERICAN WELDING SOCIETY. Organized in 1933, as a manufacturer of all kinds of Resistance Welding Machines, this company's products have won great favor by users everywhere.

Now engaged 100% on War work National is producing Spot, Press, Seam, Butt, Flash, and Special Electric Resistance Welders for Aircraft production, Shells, Bombs, Tanks, and a great variety of other armament.

In addition to its AMERICAN WELDING SOCIETY membership, National Electric is a member of the Resistance Welder Manufacturers' Association and is a sustaining member of the American Society for Metals.

Employment Service Bulletin

SERVICES AVAILABLE

A-434. Welder. Overhead, Vertical and Flat Positions.

A-435. Welding Supervisor. Desires position with going concern. All classes of supervision; pipe lines, marine buildings, bridges, tanks of all kinds. A. P. I.-A. S. M. E. codes, all tests. Married, two dependents, free to go anywhere.

ATTACK

PRODUCTION PROBLEMS

with

RESISTANCE WELDING

In recent months, Resistance Welding has proved to be much more than a good way to assemble metal products. It is helping to make more and better war materials by producing parts at high speed and low cost that formerly required slow and expensive casting or machining operation. It is providing a variety of ways to eliminate bolts, rivets and other fastening devices; to produce smooth, unbroken surfaces that require less preparation for finishing; to cut down weight; to increase strength; to simplify the construction of many products.

In addition, Resistance Welding is helping to keep other equipment on the job by solving repair and maintenance problems and in the conservation and re-use of hard-to-get materials.

An experienced welding engineer, representing one of the member companies listed here, can tell you quickly just what Resistance Welding can do for you. Why not call one in today?

RESISTANCE WELDER
MANUFACTURER'S ASSOCIATION
505 Arch Street **Philadelphia, Pa.**

RESISTANCE WELDER MANUFACTURERS ASSOCIATION · RWMA

MEMBER COMPANIES

Welding Machines Mfg. Company, Detroit, Mich.
Acme Electric Welder Company, Los Angeles, Calif.
American Electric Fusion Corporation, Chicago, Ill.
Eisler Engineering Company, Newark, N. J.
Expert Welding Machine Company, Detroit, Mich.
Federal Machine and Welder Company, Warren, Ohio
Multi-Hydromatic Welding and Manufacturing Co., Detroit, Mich.
National Electric Welding Machines Co., Bay City, Mich.
Progressive Welder Company, Detroit, Mich.
Swift Electric Welder Company, Detroit, Mich.
Taylor-Hall Welding Corporation, Worcester, Mass.
Taylor-Winfield Corporation, Warren, Ohio
Thomson-Gibb Electric Welding Co., Lynn, Mass

ASSOCIATE MEMBER COMPANIES

P. R. Mallory and Co., Indianapolis, Ind.
S-M-S Corporation, Detroit, Mich.
Electroloy, Inc., New York, N. Y.
Welding Sales and Engineering Co., Detroit, Mich.

NEW PRODUCTS

The Society assumes no responsibility for the validity of claims in this Section

WELDING ROD TO CONSERVE NICKEL

To conserve nickel for our war effort, so that it can be used where it will do the most good, the American Manganese Steel Division of The American Brake Shoe & Foundry Company, Chicago Heights, Ill., now has available a new manganese steel welding rod known as V-Mang.

An alloy steel containing 12 to 14% manganese, molybdenum and other elements, this electrode has resulted from research started by Amsco's metallurgists several years ago looking for a better welding rod. It will replace Amsco nickel-manganese steel electrodes, except in a few exceptional cases, thus conserving this critical metal without hampering reclamation of manganese steel and other ferrous equipment parts so necessary at this time.

ELECTRODES FOR ARMOR PLATE WELDING

Three electrodes known as AW-1, AW-2 and AW-3 and developed specifically for the welding of armored vehicles according to Army Ordnance Dept. Specifications AXS-492 and AXS-497 are now being manufactured by the Harnischfeger Corporation, Milwaukee, Wis., makers of P & H-Hansen welders and electrodes.

Harnischfeger engineers worked in co-operation with Government technicians on the development of these armor plate welding classifications and procedures from the very start. Details of the new electrodes and their application pertaining to armor welding are restricted to prime and subcontractors qualifying under Ordnance regulations, and are available only on application through Harnischfeger field representatives.

CAPACITOR WELD UNIT

Developed to meet the increasing demand for power and control units for capacitor-discharge welding—particularly in the welding of aluminum for aircraft—a new unit of this type, the Weltronic "Revers-O-Charge," is announced by Weltronic Corporation, 3080 E. Outer Drive, Detroit, Mich.

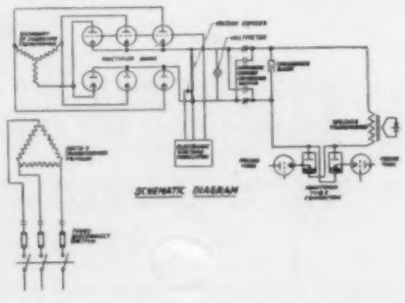
The new Weltronic "Revers-O-Charge" unit, in addition to assuring high power-factor with balanced 3-phase load and minimum peak kva. demand, embodies numerous features said to be entirely new to the particular field and designed to simplify control, improve operation and increase reliability and flexibility.

From an operating standpoint, the unit is simplicity itself. Near the center of the

dead-front panel is mounted a voltage regulator dial, which permits controlling the charge of condensers to the voltage desired—as indicated by the voltmeter at the top of the panel. This voltage is maintained to plus or minus 2%. Voltage may be raised or lowered with the condensers charged, merely by turning this dial.

The "Revers-O-Charge" feature also makes possible the partial recharging of condenser by the collapse of the field of the welding transformer after each weld, since the condensers are charged in opposite directions for each weld. This enables a material reduction in line and rectifier loads, and provides increased protection against line-surge at the beginning of actual charge.

It is designed for operation on 230/460 v. 3-phase and is available for either 60- or 50-cycle. (Controls operate on 110 v. through a control circuit transformer.) Units for 25-cycle operation may also be obtained at additional cost.



HIGH-TENSILE STRENGTH SOLDER

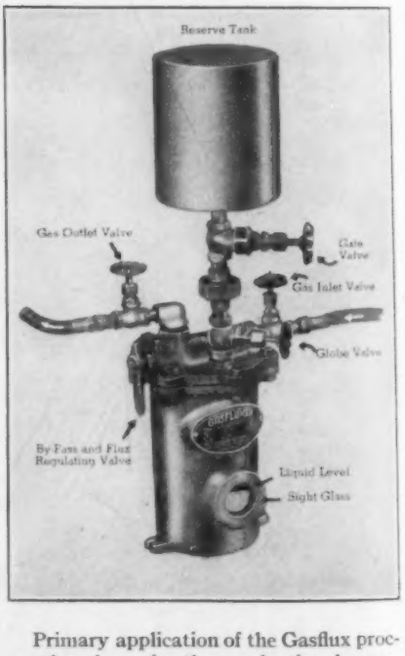
A special solder developed for the soldering of all hard-to-solder metals such as aluminum, aluminum alloys, die cast, Dowmetal, Almico, etc., has been perfected by the Lloyd S. Johnson Company, 2241 Indiana Ave., Chicago, Ill. The material is exceptionally free-flowing and provides unusual tensile strength in sheet metals and extruded aluminum. It retains color of aluminum and Dowmetal, and is corrosion resistant. Solder comes conveniently rolled $^1/_8$ in. square and runs approximately 270 in. to the lb. Price is $2.50 per lb. or 10 lb. for $18.70.

GASFLUX

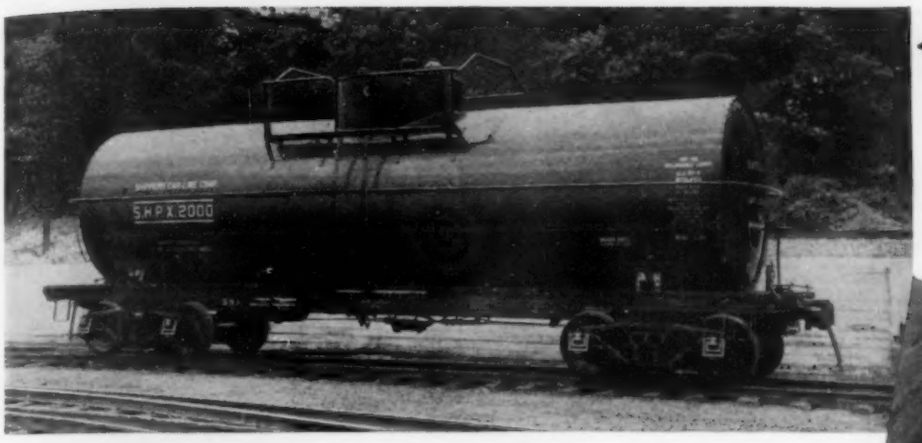
Gasflux consists of effective fluxing ingredients carried in solution in a highly volatile liquid and is prepared by a special process. It is not explosive but is inflammable and evaporates rapidly when exposed to the air.

In operation the Gasfluxer is filled with Gasflux to the top of the sight glass and is connected into the fuel gas line leading to the welding torch with a short piece of hose.

The fuel gas passing through the Gasfluxer picks up the flux in vapor form and delivers it to the torch in the gas. *The flux is in the flame.* Presence of Gasflux is determined by the green color of the flame. No special tips, torches or other equipment are required.

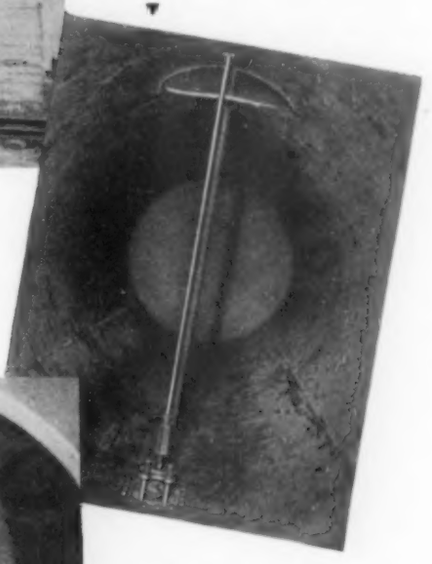


Primary application of the Gasflux process has been in the production bronze-welding field. It is equally valuable for maintenance work but the savings in costs of up to 40% which can be readily seen in production are not as easily determined in maintenance. It saves 10% on bronze-



First all-welded tank car made of Lukens Nickel-clad steel, at Milton, Pa., plant of American Car & Foundry Company.

Pure Nickel valve control rod operates bottom discharge valve. Nickel syphon installed for discharge through dome.



ALL-WELDED Construction for Tank Cars of NICKEL-CLAD STEEL

No. 131 Nickel Arc Welding Electrodes used for all nickel welding

More proof of the value of all-welded construction is this Nickel-clad steel tank car ...one of five built at the Milton, Pa., shops of American Car and Foundry Company. Welding is employed because the heating and cooling cycle incident to loading sometimes caused loosening of rivets.

Built to carry a variety of chemicals and other products which need Nickel's protection against metallic contamination, each of these cars is 32 ft. long, 86¼ in. diameter, 10,000 gal. capacity, with heads flanged and dished, fittings either Pure Nickel or lined with Nickel sheet.

In welding, plates are first bevelled on steel side, fitted, tacked, and Unionmelt welded on outside. Joints on Nickel side are then chipped to obtain a clean, uniform groove, and two layers of nickel weld deposited with No. 131 Nickel Arc Welding Rod. All welds X-rayed to meet the high standards required by I.C.C. specifications.

For further information on welding of Nickel-clad steel write for Bulletin T-4, "Methods for the Fabrication of Clad Steel Plate." Address:

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street New York, N. Y.

Interior of Nickel-clad dome with manhole cover closed.

Nickel-clad steel tank before application of heads. Paper used to protect Nickel surface during construction.

Welding Nickel interior of dome.

Photos courtesy American Car & Foundry Company

FIRST THINGS FIRST . . . With the Nation at war, supplies of Monel, Nickel and Nickel Alloys are needed for our armed forces. All efforts must now be aimed toward victory. In the meantime, The International Nickel Company will continue to issue information which it is believed will be of interest to metal users who are concerned with the war needs of today and the peace-time progress of the future.

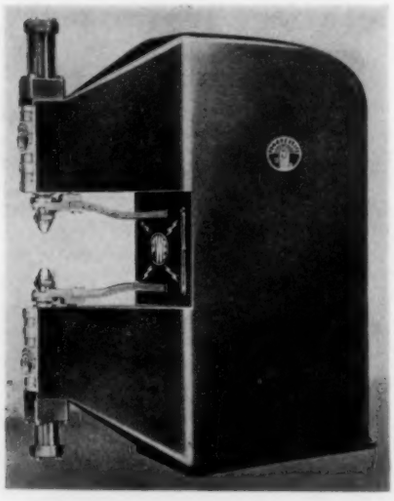
INCO NICKEL ALLOYS *ARE YOUR ALLIES*

MONEL • "K" MONEL • "S" MONEL • "R" MONEL • "KR" MONEL • INCONEL • NICKEL • "Z" NICKEL
Sheet . . . Strip . . . Rod . . . Tubing . . . Wire . . . Castings

welding rod of which there is a present shortage. It is manufactured by the Automatic Gasflux Mfg. Co., 198 Wayne St., Mansfield, Ohio.

FORGE WELDER CONTROLS

A welder in which the temperature at the weld itself automatically controls weld and heat-treat current and operating cycle, and which is completely self-compensating for all such variations as normal difference in metal thickness, induction and short-circuiting losses, presence of scale, etc., has been announced by Progressive Welder Company of 3050 E. Outer Drive, Detroit, Mich.



Designed for resistance welding of heavy sections and of special alloy steels—such as homogeneous and face-hardened armor-plate, and for ship-building—the new Progressive "Temp-A-Trol" forge welder both spot welds and heat treats the weld. Close control of weld nugget size, ductility and grain refinement are thus obtained. It is said that the welder also avoids annealing of hardened surfaces in plate.

CLEANING BRUSH

A new power-driven end brush of particular importance to war production is announced by The Osborn Manufacturing Company, Cleveland, Ohio.

The new brush is designed particularly to facilitate the cleaning of slag, scale or oxidation from welds on inside corners (see illustration), as well as other locations which are difficult of access.

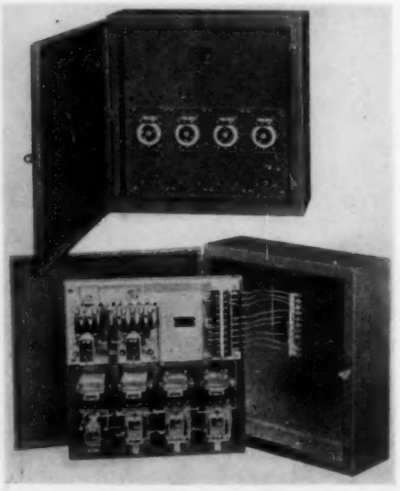
An important feature of the new brush is the fact that it can be used in all standard power tools, whether air or electric. This facility is permitted by the special holder which has the additional advantage of permitting instant replacement of the brush part.

The brush proper measures only $\frac{1}{2}$ in. across the end, or brushing surface, and may be had with any one of three diameters of wire—0.025-in. for Type No. 91-S-2 brush, 0.035-in. for Type No. 91-S-3 and 0.090-in. for Type No. 91-S-4.

"SAFRONT" WELDER CONTROL

Safety, simplicity and flexibility are the keynotes of the new "Safront" Resistance Welder Control, introduced by the Square D Company's Industrial Control Division, 4041 North Richards St., Milwaukee, Wis.

The new "Safront" construction places all electrically energized parts behind a protective panel, thus eliminating any danger of shock while timing adjustments are being made. Calibrated timer adjustments are completely accessible on panel front.



The design provides a separate pneumatic timing device for each step of the welding cycle. Timing periods from 3 to 100 cycles are accurately obtained, simply by turning a small knurled wheel.

NEOPRENE COATED SAFETY CLOTHING

A new line of safety clothing has just been placed on the market by the Safety Clothing & Equipment Co., 7016 Euclid Ave., Cleveland, Ohio. It is Neoprene coated clothing and includes many items used by welders—welding jackets, aprons, sleeves, coveralls, leggings and gloves. This clothing provides protection against heat, sparks, splash, acids, chemicals and oils—in fact, it is recommended as the best all-purpose protective clothing on the market. Most items are available in light- or heavy-weight material.

A new folder describing this Neoprene coated clothing has just been issued by the maker who will be glad to forward copy on request.

HEAT EXCHANGER SHELLS

In the fabrication of heat exchanger shells, or other cylindrical bodies, a smooth working mechanical drive is a requisite while arc welding the circumferential seams. As demands for increased production grew in the welding department at the Johnson & Jennings Co.—Cleveland, Ohio, it became evident that serious limitations in floor space and crane capacity had to be relieved.

To solve the problem, a portable mechanical drive was needed that could be placed in position quickly when and where it was needed. This unit could eliminate the use of cranes for transferring the shells from the original set-up position. This mechanical drive could be moved easily from shell to shell as the requirements of welding operators would call for its use.

This efficient mechanical drive was designed and built in four weeks at a shop cost of $675. It was designed and built under the direction of John S. Green—works manager of the company.

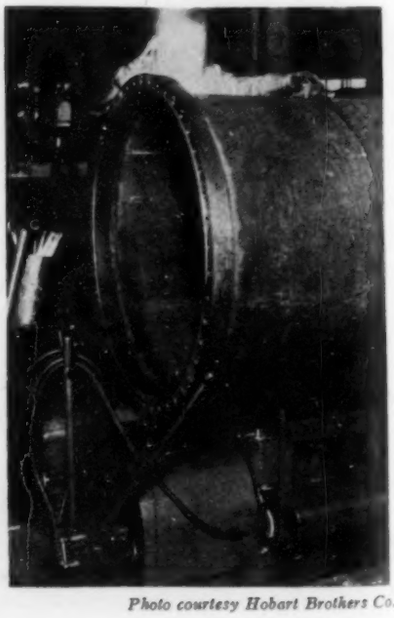


Photo courtesy Hobart Brothers Co.

DETECTS 2% FLAWS in 2½ INCHES of STEEL!

KELEKET X-RAY

INDUSTRIAL EQUIPMENT

THIS machine is the KELEKET 220 KV Industrial Unit—one of the KELEKET units used to detect flaws in welds and castings before expensive fabricating.

Industrial units engineered and developed by Kelley-Koett cover the field of metal inspection from the lightest aluminum sheets to 5-inch steel and will detect flaws as small as 2% of material thickness.

KELEKET'S 41 years of X-ray experience is now available to industry. Our engineers will gladly consult with you on what X-ray will do for you and how X-ray will help solve your inspection problems. For information write

THE KELLEY-KOETT MFG. CO. . . . *Industrial Division*

218-5 West Fourth Street, COVINGTON, KY.

Representat'ves in 64 cities

PIONEER CREATORS OF *QUALITY* X-RAY EQUIPMENT SINCE 1900

SECTION ACTIVITIES

CALENDAR OF EVENTS

Society and Section Meetings

(For further details see Section Activities)

NEW YORK SECTION—May 12, 1942.
LOS ANGELES SECTION—May 21, 1942.
MARYLAND SECTION—May 15, 1942.
PHILADELPHIA SECTION—May 18, 1942.
NORTHERN NEW JERSEY—May 19, 1942.
NORTHWEST SECTION—May 14, 1942.
CHICAGO SECTION—May 15, 1942.
LOS ANGELES SECTION—June 18, 1942.
OKLAHOMA CITY SECTION—June 4, 1942.

BIRMINGHAM

Mr. H. C. Hettelsater, Standards Engineer of the Harnischfeger Corp., addressed the February 18th meeting of the Birmingham Section on the subject, "Construction and Maintenance of Heavy Machinery, Ordnance Materials and Railroad Equipment." Mr. Hettelsater's talk was illustrated and covered the various types of heavy duty equipment.

CANAL ZONE

Members and guests of the Canal Zone Section enjoyed a very pleasant meeting on March 9th at the Pedro Miquel Clubhouse. The meeting was preceded by a dinner. As the newly elected Chairman, Mr. Cannell, was in the "States" at the time, the Secretary, Mr. R. E. Holick, performed the duties of toastmaster. Mr. Emmett Nuckolls gave a synopsis of the development of welding. The guest speaker, Col. Hans Kramer, Supervising Engineer of the Special Engineering Division of the Panama Canal, gave a short talk and included several items of particular local interest to Canal Zone welders.

CHICAGO

At the March 20th meeting of the Chicago Section, Mr. J. H. Cooper, Welding Engineer with The Taylor-Winfield Corp., of Warren, Ohio, presented a combined talk on "Stored Energy Welding" and "Resistance Welding on Defense Items." Mr. S. M. Humphrey, Chief Electrical Engineer of the same concern, was scheduled to give the first subject, but unfortunately encountered difficulty in making plane connections and could not be present. However, Mr. Cooper was well qualified and gave an excellent story on all the phases of resistance welding. He also had a large display of welded items, which created an unusual amount of interest. The meeting was very well attended and a lively discussion period followed Mr. Cooper's talk.

April 17th—"Metal Transfer in the Metallic Arc," by Dr. Louis J. Larson, Consulting Welding Engineer, Milwaukee, Wisconsin. The speaker is a well-known authority and presented his latest researches on the above subject.

Mr. T. B. Jefferson, Editor of the *Welding Engineer*, has been appointed by the Board of Directors to serve as Secretary-Treasurer of the Chicago Section taking the place of Mr. M. S. Hendricks, who has served in this capacity for many years. Mr. Hendricks recently left Chicago to operate his farm near Mundelein, Ill.

Mr. H. M. Downing of the Lincoln Electric Co., recently was appointed Chairman of the Membership Committee replacing Mr. J. H. Hruska, who is so involved in defense work that his society activities were necessarily limited. A membership drive is in progress and is showing good results.

May 15th—"Certified Weldments," by R. W. Sternke of the Lakeside Bridge and Iron Co., Milwaukee, Wis. The speaker's company is engaged in the fabrication of much important equipment where controlled welding is employed and he has an interesting story to tell.

CINCINNATI

The Cincinnati Section has held eight regular monthly meetings since September 1941—the last of these education meetings, for this season, was on May 4th. The annual meeting will be held in June. At the April 6th meeting, Mr. W. R. Mayberry, Plant Superintendent, Line Material Co., spoke on "A.C. Welding *versus* D.C. Welding."

CLEVELAND

Members and friends of the Cleveland Section enjoyed one of the 1941–42 season's most instructive and entertaining get-togethers Wednesday evening, April 8th, at the Cleveland Engineering Society building.

Approximately 75 were at the dinner preceding the meeting, and over 200 were present for the two speeches on the program.

Main event was a sound motion picture showing the construction of the new Chrysler Tank Arsenal in Detroit and its production of 30-ton tanks. This was preceded by a talk by Major W. B. McClelland, chief of the automotive division, Cleveland Ordnance District.

Major McClelland explained the method by which ordnance projects are designated, reviewed various types of tanks now in production and pictured the many problems connected with execution of the ordnance program. He invited any members present to submit ideas offering possible solutions to various problems. He pictured the burden placed upon the welding industry by the volume of ordnance requirements. The greatest need, he said, is for a satisfactory high-speed method of production welding of tanks. Manual welding, he said, is out of the question since several hundred hours of welding are required per tank. There just aren't enough men to call on to hand-weld all the tanks required. Another problem is in getting welding operators to the extent they are needed.

"Problems of War Production" was the subject scheduled for a talk by C. R. Terry, State Director of Contract Distribution Branch of the War Production Board. Mr. Terry's place was taken by Arthur T. Stanton, member of the Washington staff.

Mr. Stanton's opening remarks were on the extreme seriousness of the present situation and the severe need, not only for "all-out" effort by existing war production facilities, but also conversion of every available idle machine and idle minute to the war effort.

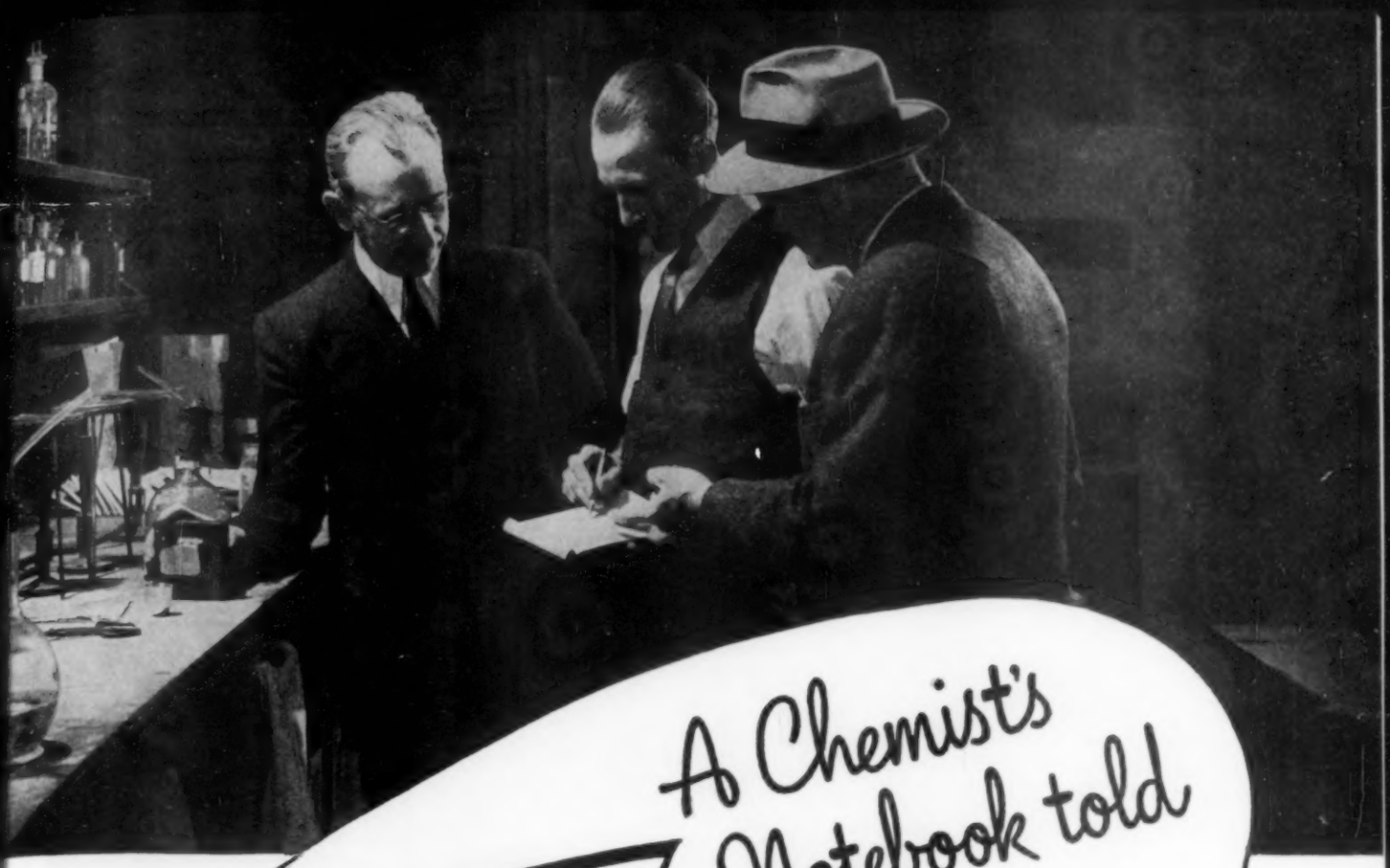
The "coffee talk" following the dinner was by Chief Ed Connor, director of recreation and physical education with Goodyear Tire and Rubber Company of Akron.

Talking on "Keep Fit by What You Eat," Chief Connor evoked many a round of laughter by his remarks on how and how not to eat.

May 8th was the date set for the annual symposium of the Cleveland section. Five papers, three in the afternoon and two in the evening, are scheduled. Speakers include: E. D. Morriss, Linde Air Products Company; George Hoglund, Aluminum Corporation of America; Ben Wise, Federal Machine and Welder Company; C. J. Holslag, Electric Arc, Inc.; and Leon C. Bibber, Carnegie Illinois Steel Corporation.

The conference started at 2 P.M., with dinner at 6:30 and evening session at 8.

Credit for the past season's fine programs goes to J. Robert Kriz, chief inspector, The James H. Herron Co., chairman of the program and papers committee; J. R. Morrill, The Lincoln Electric Co., who arranged for the dinner speakers;



A Chemist's Notebook told the Story

BECAUSE of the many variables involved, running down the cause of weld failures is sometimes as difficult as looking for a black cat in a cellar.

At one plant, recently, pronounced weld porosity was encountered on starting automatic welding of a stainless clad container 70′ long x 12′ in diameter.

After experimenting with various techniques and different types of electrodes, no two successive X-rays were found acceptable. At this point the Murex engineer suggested analyzing the mild steel portion of the stainless clad plate. When this proved to be Silicon-killed steel containing appreciable quantities of Manganese and Silicon, switching to a highly fluid, "hot" electrode provided the answer. Following the change, only 5 or 6 pinpoint defects occurred in each 100 linear feet of welding.

The accumulated experience of our engineering staff with welding procedure, weld design and shop practice—representing thousands of hours of work and observation under all kinds of conditions—is available to help speed war production in your plant.

METAL AND THERMIT CORPORATION
120 BROADWAY, NEW YORK, N. Y.

Specialists in welding for nearly 40 years. Manufacturers of Murex Electrodes for arc welding and of Thermit for repair and fabrication of heavy parts.

MUREX
ARC WELDING ELECTRODES

ALBANY • CHICAGO • PITTSBURGH • SO. SAN FRANCISCO • TORONTO

Les Pfeil, president, Universal Power Corp., secretary of the section, who assisted in obtaining speakers; and J. F. Maine, chief engineer, Republic Structural Iron Works Co., chairman of the section, whose able leadership was responsible for all activities of the section.

DETROIT

One of the most widely discussed types of new welding equipment, designed for use in aircraft fabrication of aluminum sheet metal, was the subject of a lecture at the April 3rd meeting of the Detroit Section in the Horace H. Rackham Educational Memorial Building. The discussion was given by Maurice Sciaky, assisted by C. W. Dodge. Members of the American Institute of Electrical Engineers and the Industrial Electrical Association were invited to attend the meeting.

The following officers have been elected by the Detroit Section for next years' activities: *Chairman*, Otis Smith, Weldit Acetylene Co.; *Vice-Chairman*, Earl Foss, Murray Corp. of America; *2nd Vice-Chairman*, Henry Neitzel, Whitehead & Kales Co.; *Secretary-Treasurer*, George Sieger, S-M-S Corp.; *Executive Committee*, J. M. Diebold, C. E. Phillips, Russ Stagg, V. Fegley, Ed Biederman, Frank Coates, L. A. Danse, Larry Boelter, M. Scott, Lee Clark, H. Cogan, C. J. Dekker, L. Benkert, W. Anderson, G. Friebel.

HAWAII

We quote below from a letter of the Secretary of the Hawaiian Section dated March 19.

"Here at last is word from your War Zone post, the Hawaiian Section of the AMERICAN WELDING SOCIETY.

"Things have changed quite a bit here in Hawaii and I might say are changing more so, every day.

"We're sorry we are not able to give you complete information regarding SOCIETY meetings, but believe you will understand when we say, during the day everyone is working like mad. At night we have blackout and all pedestrians and cars are off the streets unless engaged in some necessary work. This should explain why we do not have meetings and are forced to practically hibernate.

"We cannot help but feel very shortly everything will return to a more normal way of living and until that time, we are forced to ask you not to forget us, but to let us function the best we can under the prevalent conditions."

INDIANA

Mr. J. R. Wirt, Welding Engineer from the Delco-Remy Division of General Motors Corp., was the speaker for the April meeting held at the Antlers Hotel on Friday, April 3rd. His subject was "Some Problems Involved in the Change from Domestic to War Production."

A large number of members and friends attended this meeting. Slides of some of the new processes developed to meet present production requirements were shown. The use of resistance welding and silver brazing was particularly interesting.

A dinner was served for members and guests prior to the regular meeting.

LOS ANGELES

May 21st—Resistance Welding.

June 18th—Welded Dirt Removing Equipment; Railroad Welding; Aviation Inspection.

MARYLAND

May 15th—Annual Banquet and demonstrations.

MILWAUKEE

The March meeting of the Milwaukee Section was held on the 27th. An after-dinner talk on "Popular Astronomy" was given by Edward Halbach, Electrical Engrg. Dept., Marquette University. The welding address was given by Mr. David Arnott, Vice-President and Chief Surveyor, American Bureau of Shipping, who spoke on "Welding in the Shipbuilding Industry."

NEW YORK

The New York Section of the AMERICAN WELDING SOCIETY held its regular monthly technical meeting on Tuesday, April 14, 1942, at the Engineering Societies Building. Chairman for the evening, which was devoted to railroads, was Mr. E. Vom Steeg, Jr., Welding Specialist, General Electric Company.

Speaker of the evening was Mr. James Partington, Manager, Engineering Department, American Locomotive Company, New York, who spoke on the subject, "Welding Applied to Locomotives." Mr. Partington described the numerous welding operations as applied to steam, electric, and Diesel-electric locomotives. He particularly stressed the welding of locomotive boilers, locomotive and tender underframes, cylinders, cab construction, tank construction, and locomotive streamlining. His talk was accompanied by numerous lantern slides and was unusually interesting and well received.

Following Mr. Partington's talk, the General Electric Company presented its motion picture, "Railroadin'." The 30-minute picture in sound, as well as color, was particularly striking, covering as it did the history of railroads as well as behind-the-scenes views of what makes railroads click.

During the half-hour period preceding the technical meeting the regular "Welding and Cutting Question Box" session was held with Mr. H. R. Morrison, The Linde Air Products Company, New York, acting as Chairman.

NORTHERN NEW JERSEY

At a recent meeting of the Executive Committee of the Northern New Jersey Section, plans were made for the establishment of an Industrial Advisory Service for the industries of the Northern New Jersey area. The purpose of this service is to put as much welding knowledge and experience as possible at the disposal of industrial plants which are engaged in war work. A survey is being made of the membership of the section to determine what members are able and willing to contribute to this activity by furnishing information on problems relating to all forms of welding. The wisest possible publicity will be given to this service with an invitation to send inquiries to the section Secretary who will contact the members who are able to help with each inquiry and relay the suggestions received to the plant from which the inquiry originated.

Action was also taken by the Committee to develop a better coordination between welding schools and local industries. It was decided to make a thorough survey of existing schools, both public and private, and offer them the services of the section Educational Committee in keeping their instruction procedures as closely as possible in line with local employment requirements. It is felt that the section Educational Committee can be of very great service by building a better acquaintance and understanding between the schools and the prospective employers. The Educational Committee is already working on a plan for a course of lectures on the fundamentals of welding theory and practice, to be given during the coming year.

The regular monthly meeting of the Northern New Jersey Section was held on April 21st at the Essex House, Newark, N. J. "Welding in the Pressure Vessel Industry" was presented by J. T. Phillips, Superintendent, Boiler Shop, Foster-Wheeler Corp. Mr. Phillips explained how the rigid requirements of code welding was met by careful attention to the factors of design, shop equipment, special fixtures, engineered procedures and methodical testing and inspection. A movie, "Manufacture of Large Diameter Pressure Vessels," was presented through the courtesy of the M. W. Kellogg Company. This film showed code welding in action.

NORTHWEST

Mr. Lee Wallner, Shipbuilding Division, Zenith Dredge Company, spoke on "Welding in Shipbuilding" at the April 16th meeting of the Northwest Section, which was held at the Coffman Memorial Union, University of Minnesota.

An Annual Meeting will be held by the Northwest Section on May 14th.

OKLAHOMA CITY

The Oklahoma City Section recorded a very excellent attendance for its April 9th meeting in Oklahoma City. Twenty-three guests were present, thus constituting an excellent group for future memberships.

Through the courtesy of the Oklahoma City Navy Recruiting Service "Eyes of the Navy" was shown. This picture was descriptive of the training of pilots for naval service.

Mr. C. I. Lundgren, Taylor-Winfield Representative, presented the principal

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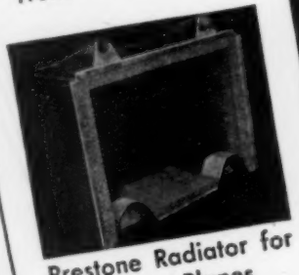

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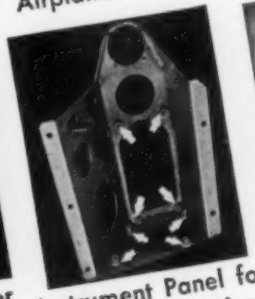

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address of the evening. His topic was "Resistance Welding in Industry" and was accompanied with some very excellent pictures of resistant-welding equipment in operation.

"Heat-Treating Hints," a film in sound and technicolor, was shown through courtesy of the Lindberg Engineering Company. This is an excellent film for any section which has a place for it on their program.

June 4th—Annual Meeting, installation of officers and Dutch Lunch.

PITTSBURGH

Before one of the largest attendances of the year, on the night of March 18th, Mr. H. M. Priest, Engineer Railroad Research Bureau, U. S. Steel Corporation Subsidiaries, gave a most thorough and interesting lecture on the subject of "Engineering Essentials for Welders."

With the use of some of the clearest slides ever shown on the screen here and some simple working models, Mr. Priest illustrated very definitely the points in his discussion he wanted to impress on those present.

Following the lecture many questions were asked by those present and it was voted by all a most interesting meeting.

ROCHESTER

On April 2nd Dr. C. W. Mason, professor of microscopy and metallography of the Chemistry Department of Cornell University, gave a very interesting talk on "Crystal Formation, Growth and Phase Changes," and some very unusual demonstrations of crystal formation, growth and change.

March 5th—Mr. Paul James of the Lincoln Electric Co. also gave a very educational talk on welding electrodes, types and uses. The discussion afterward brought out many interesting problems for Mr. James to answer. This meeting was very well attended by members of the Rochester Chapter.

For the May meeting the Section secured Mr. Leon C. Bibber, Welding Engineer, of Carnegie Illinois Steel Corporation, Pittsburgh, Pa. His subject will be "Elements of Welded Joints."

On March 28th a bowling party for members and guests was held. There were about seventy men present. Purpose of this party was mainly to acquaint different members with each other. It has been proposed that this be made a monthly affair for next year.

SAN FRANCISCO

The following are the newly elected officers of the San Francisco Section: *Chairman*, Frank Longo, Southern Pacific Co.; *Vice-Chairman*, M. Maltseff, Western Pipe & Steel Co.; *Secretary*, J. G. Bollinger, Air Reduction Sales Co.; *Treasurer*, H. W. Saunders, Air Reduction Sales Co.

PHILADELPHIA

"Welding of Buildings," designed and constructed by the Bureau of Yards and Docks of the United States Navy, was a most interesting talk given by Mr. A. Amerikian, Design Engineer, Bureau of Yards and Docks, at the April 20th meeting of the Philadelphia Section.

"The Welding of High Pressure Piping" will be the subject of the May 18th meeting. "1—As Applied to General Pipe Fabrication" will be presented by Mr. Harry Irrgang, Supt., The W. K. Mitchell Company, and "2—As Applied to Marine Construction" will be presented by Mr. H. O. Klinke, Welding Engineer, The Philadelphia Navy Yard. The meeting will be held as usual in the Engineers' Club, 1317 Spruce Street, Philadelphia, at 8:00 P.M.

The Philadelphia Section announces the election of the following officers for the fiscal year: *Chairman*, Harry W. Pierce, New York Shipbuilding Corp.; *Vice-Chairman*, M. W. Brewster, Westinghouse Elec. & Mfg. Co.; *Treasurer*, R. D. Thomas, Arcos Corporation; *Secretary*, K. W. Ostrom, Arcos Corporation; *Past-Chairman*, A. J. Raymo; *Executive Committee* (for three years): W. W. Barnes, R. B. Clements and O. J. Pearre.

ST. LOUIS

Mr. J. H. Cooper, Welding Engineer of Taylor Winfield Corp., spoke at the April 10th meeting of the St. Louis Section on the subject, "Characteristics and Applications of Resistance Welders Particularly as Applied to War Work." A quantity of samples and slides were shown.

SOUTH TEXAS

The South Texas Section held a regular meeting at the Texas State Hotel, Houston, Texas, on March 20th. Mr. Ira B. Yates, of the Wilson Welder and Metal Company, Inc., New York, was guest speaker for the evening, and offered a very interesting discussion on the magnitude of welding in the defense effort.

The rapid growth of the welding industry is evidenced by the fact that more than 48,000 welding units were in use in 1941 compared with some 6000 units in use in 1938, and under the stimulus of the war production effort the further growth of this giant in 1942–43 will be little short of phenomenal.

Chairman J. M. Hugen asked for a general discussion of the vocational training system being sponsored by the government, and several members and visitors indicated that their respective companies had employed men who received their initial training in these schools. One representative of a local shipbuilding concern said his company was able to get approximately 95% of useful welders from the vocational groups. Careful selection of these men is necessary, however, and the potential employer sends a welding superintendent to the school classes to interview the men individually and observe their work. This training is considered only basic and further training is given each man after he reaches the yard, according to the speaker.

WASHINGTON D. C.

The sixth regular meeting of the Washington Section was held at the Potomac Electric Power auditorium on March 24th. Mr. LaMotte Grover of the Air Reduction Sales Company discussed bridges and structural welding. Mr. Grover has been following this phase of welding from the standpoint of plate fabrication, design and construction for many years. He pointed out the continual replacement of riveted structures by welded structures and increased interest in welding within the State Highway Departments and the railroads. It was shown that considerable weight saving can be effected by judicious use of flame cutting to shape tension and compression members integral with the beam sections of bridges and buildings. This technique eliminates the gusset plates. Illustrations were shown of arch bridges wherein the thrust from the welded steel beams was held against concrete abutments. Rigid framing for building construction was also discussed. The manner of prefabricating columns and parts of roof girders with subsequent replacement of center sections was shown. Typical sections through steel buildings with and without tension members to hold the columns together were discussed.

Following the speaker's paper, a lively discussion followed and the meeting was adjourned at 11:00 P.M.

WESTERN NEW YORK

The March meeting of this section was held Friday evening, March 20th at the Markeen Hotel and the usual dinner and business meeting preceded the speaker of the evening.

The slate of officers for the coming year was announced and the result of the coming election will be announced next month.

An interesting illustrated talk on "Design and Construction of Welded Bridges and Buildings" was given by Mr. F. L. Plummer, Chief Research Engineer, Hammond Iron Works, Warren, Pa. Mr. Plummer's wide experience as a consultant and technical adviser together with his teaching experience made this talk highly instructive and the discussion after the meeting helped to solve many problems of design and fabrication.

YORK-CENTRAL PA.

Mr. Arthur J. Taymo, Supervisor of Welding at the Baldwin Locomotive Works, spoke on the subject, "Welding of Heavy Structures and Current Applications of Arc Welding to Railway Transportation Equipment," at the April 15th meeting of this Section.

Annual Meeting
American Welding Society
Oct. 11-15